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REPORTS

FROM

COMMITTEES:

ELEVEN VOLUMES.

— (10.) —

SEWAGE (METROPOLIS).

Session

4 *February* —— 29 *July* 1864.

VOL. XIV.

1864.

REPORTS FROM COMMITTEES:

1864.

ELEVEN VOLUMES:—CONTENTS OF THE

TENTH VOLUME.

N.B.—*THE* Figures *at the* beginning of the line, *correspond with the* N° *at the foot of each* Report; *and the* Figures *at the* end of the line, *refer to the* MS. Paging *of the Volumes arranged for The House of Commons.*

SEWAGE (METROPOLIS).

487. REPORT from the Select Committee appointed to inquire into any Plans for dealing with the SEWAGE of the METROPOLIS and other large Towns, with a view to its Utilization to Agricultural Purposes; with the PROCEEDINGS of the COMMITTEE, MINUTES of EVIDENCE, APPENDIX, and INDEX - - - - - - - p. 1

REPORT

FROM THE

SELECT COMMITTEE

ON

SEWAGE (METROPOLIS);

TOGETHER WITH THE

PROCEEDINGS OF THE COMMITTEE,

MINUTES OF EVIDENCE,

APPENDIX AND INDEX.

Ordered, by The House of Commons, *to be Printed,*
14 *July* 1864.

487.

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Martis, 26° *die Aprilis,* 1864.

Ordered, THAT a Select Committee be appointed, to inquire into any Plans for dealing with the Sewage of the Metropolis and other large Towns, with a view to its utilisation for agricultural purposes.

Veneris, 29° *die Aprilis,* 1864.

Committee nominated of—

Mr. Cowper.
Mr. Walpole.
Mr. Bright.
Mr. Adderley.
Sir William Russell.
Sir Frederic Smith.
Lord Fermoy.
Sir Joseph Paxton.
Mr. Caird.
Mr. Tite.
Mr. Leader.
Mr. Hibbert.
Mr. Sclater-Booth.
Dr. Brady.
Lord Robert Montagu.

Ordered, THAT the Committee have power to send for Persons, Papers, and Records.

Ordered, THAT Five be the Quorum of the Committee.

Lunæ, 9° *die Maii,* 1864.

Ordered, THAT the Returns relative to Sewage (Metropolis) and Sewage (Metropolis, &c.) [presented 6th May 1864] be referred to the Committee.

Sewage (Metropolis):

Copy of all Advertisements published by the Metropolitan Board of Works, since its formation, calling for Tenders for dealing with the Sewage, as well as of all Reports or other information in any way affecting or relating to the applications which have been made to the Board for the Sewage; and of all Reports by the officials of the Board or the Main Drainage Committee upon the said plans or proposals.—(Mr. *Ayrton.*)

Sewage (Metropolis, &c.):

Copies of all Advertisements published by order of the Metropolitan Board of Works since its formation, calling for Tenders for the utilization of the Metropolitan Sewage, or any portion of the same, for agricultural purposes:

Of Proposition from the Hon. W. Napier and W. Hope, esquire, for a concession of the Sewage of the northern area of the Metropolis, ordered by the Main Drainage Committee, No. 69, 1861:

Of Reports of Mr. Bazalgette, C.E., and Mr. Smith, solicitor, on the Proposition of Messrs. Napier and Hope for a concession of the Sewage of the northern area of the Metropolis, ordered by the Main Drainage Committee to be printed, No. 70, 1861:

Of Report of the Main Drainage Committee on the Tenders for taking the Sewage of the Metropolis, and Communications relating thereto, 1st January 1862, No. 71:

Of Letters from Messrs. Napier and Hope, Mr. Bramwell, Mr. Townsend, and Mr. Moore in reference to the proposed Concessions, No. 73, 1862:

Of further Communications from Mr. Shepherd, Messrs. Napier and Hope, Mr. Bramwell, Mr. Moore, &c. (including the Report of Mr. Hopkins), No. 74, 1862:

Of Letter from Mr. Hemans with reference to certain statements in the Report of Mr. Hopkins, No. 77, 1862:

Of Mr. Hopkins's Reply to the foregoing:

Of the Report of the Main Drainage Committee on the Tenders for the Metropolitan Sewage, 20 July 1863, No. 121:

Of Letters relating to the utilization of the Sewage of the Metropolis, printed by order of the Board, No. 125:

And, of all Resolutions in reference to the utilization of the Metropolitan Sewage passed by the Metropolitan Vestries, District Boards, City Wards, City Corporation, or Public Meetings, of which Copies may have been forwarded to the Metropolitan Board of Works.—(Lord *Robert Montagu.*)

Mercurii, 11° *die Maii,* 1864.

Ordered, THAT it be an Instruction to the Committee to inquire into the effects of discharging the Sewage into the Brooks or Rivers.

Ordered, THAT the Committee do consist of Seventeen Members.

Ordered, THAT Mr. *North* and Mr. *Ferrand* be added to the Committee.

Martis, 31° *die Maii,* 1864.

Ordered, THAT the Return, "Pollution of Streams" [presented 19th April], be referred to the Committee.

Jovis, 16° *die Junii,* 1864.

Ordered, THAT it be an Instruction to the Committee to inquire into the arrangements now in progress for diverting the Sewage of the Metropolis.

Jovis, 14° *die Julii,* 1864.

Ordered, THAT the Committee have power to report their Observations, together with the Minutes of Evidence taken before them, to The House.

REPORT.

THE SELECT COMMITTEE appointed to inquire into any PLANS for dealing with the SEWAGE of the METROPOLIS and other large TOWNS, with a view to its UTILISATION to AGRICULTURAL PURPOSES;—HAVE considered the Matters to them referred, and have agreed to the following REPORT:

YOUR Committee commenced their inquiry by examining into all those plans for utilising, in a liquid state, the sewage of the Metropolis, which had been laid before the Metropolitan Board of Works, and were referred to the Committee by an Order of the House.

Your Committee have ascertained, from Cornish Engineers of the greatest reputation, the prices of the steam engines and pumps which would be required to raise various quantities of sewage to stated heights.

Mr. Bateman, the well-known water engineer, was examined as to the prices of the mains and pipes which would be necessary for the conveyance and distribution of sewage over land, and the estimated cost of laying them down and jointing them.

Your Committee has come to the conclusion, that it is not only possible to utilise the sewage of towns, by conveying it, in a liquid state, through mains and pipes to the country, but that such an undertaking may be made to result in pecuniary benefit to the ratepayers of the towns whose sewage is thus utilised. 1778–1784. 2398. 2839, 2840. 2879. 2885. 3350–3352. 3392, 3393. 3411. 3413. 3436–3441. 3617–3619. 3714. 3769. 4072–4078. 4090. 4093. 4106. 4180–4183. 4191. 4194, 4195.

That benefit may, in a few years, be greatly increased; for the amount of artificial manures is even at present insufficient, and the sources whence some of the most important are obtained will, in a few years, be exhausted. Other means of fertilising land must therefore be resorted to. 4785–4789. 4963–4968.

Your Committee, having examined the Chairman and Engineer of the Metropolitan Board of Works, are of opinion that more might have been done by that Board towards the profitable use of the sewage of London; and that the completion of the outfall sewerage of the Metropolis ought, at the earliest possible moment, to be followed by the adoption of a system which may convert that sewage from a nuisance into a permanent and increasing source of agricultural fertility.

Even if a pecuniary benefit were not to be secured, yet such a consideration should not deter local authorities from taking such steps as are possible to free rivers from pollution. 3843. 3844. 3972

Your Committee examined several witnesses regarding the pollution of the rivers and streams of the country.

There can be no doubt as to the injury which results from the practice of conducting sewage and other refuse matters into the rivers, from whence numerous towns, villages, and country populations derive their water-supply.

It is imperatively necessary that such a practice should be discontinued. 2815. 2816. 2720-2723. 2772, 2773. 3728, 3729. 3812. 3817. 3823. 3969. 4017. 4018. 4034. 4708. 4741-4743. No efficient artificial method has been discovered to purify, for drinking and culinary purposes, water which has been once infected by town sewage. By no known mechanical or chemical means can such water be more than partially cleansed; it is always liable to putrify again. Processes of filtering and deodorization cannot, therefore, be relied upon to do more than mitigate the evil. Water which appears perfectly pure to the eye is sufficient, under certain conditions, to breed serious epidemics in the population which drinks it.

2226. 2825-2827. 2830. 3554. 3749, 3750. 3795. 4021, 4022. 4641-4644. 4728-4738. Soils, however, and the roots of growing plants, have a great and rapid power of abstracting impurities from sewage water, and rendering it again innocuous and free from contamination.

3450-3455. 3457. 3530. 3552. 3593. 2848-2850. 2923-2934. 2987. 3483. Mr. Ffennell, the Chief Inspector of Fisheries, stated in his evidence that sewage water, in a putrifying state, is destructive to fish; a considerable increase in the amount of food for the people, and of revenue to the owners of rivers, would, therefore, result from purifying the rivers of the United Kingdom, which are now contaminated by sewage and other matters.

2825. 2826. 3820. 3823. 3497, 3498. 3606. 3845. 3848. 3953. 3968-3975. 4100. 4709. 4711. 4754. If the sewage of towns is no longer to flow into rivers, the only alternative which remains is to dispose of it on the land.

2222. 2389. 2986. 3079, 3080. 3098. 3100. 3811. 3814, 3815. 2947-2949. 2986-2991. 3172. 3176-3179. 3235-3239. 3248. 3308-3311. 3479. 3582. 3853-3857. 4009. 4264. 4268, 4269. 4283-4293. It has been decided that it is a nuisance at common law to discharge any sewage into a river. Yet the law is, nevertheless, inoperative, for want of powers to remove the nuisance.

3068-3070. 3074, 3075. 3491. 3075-3091. 3096-3099. 3134. 3847. 4010-4012. 4170, 4171. Until within the last 30 years, it has been the custom to utilise all the nightsoil and other refuse on the land. Great obstructions used to be thrown in the way of making house drains which should empty themselves into the street sewers. The use of the latter was confined to the conveyance of the surface waters of the town. There was a service of scavengers whose duty it was to remove excrementitious matters in their carts. And it was the office of the mayors of towns to take care that rivers, streams, and ponds were kept free from all noxious or filthy substances. But when the modern water-closets came into vogue, and the practice was introduced of flushing house-drains into the sewers, then the diluted nightsoil first began to find its way into rivers.

2163-2174. 3493. 4073-4078. 4101. Yet the removal of house refuse to the land would now be much easier and cheaper than it was formerly; because carriage by suspension in a liquid is the cheapest mode of transport.

4095, 4096. 4191. 4194, 4195. In many towns of Lancashire there are to this day numerous cesspits. This is the case with Manchester, where the local authorities expend about 20,000 *l.* a-year for emptying them and removing the contents to the land, and receive back 50 per cent. by the sale of the material. A system of sewerage, and the necessary works to remove all the refuse in a liquid state to the adjacent fields, would, in Mr. Rawlinson's opinion, cause a saving to the town.

3136-3142. 3151, 3152. 3157. 3180-3182. 3846. The Commissioners of Sewers and the Board of Health took no steps to prevent the introduction of the practice of flushing the refuse of houses into the street sewers, and thence into the rivers. For they were of opinion that no time should be lost in freeing habitations from the dangerous infection of putrifying substances; and assumed that when this more pressing object had been accomplished, the law would be again respected, and measures would be taken to free the rivers and restore the refuse once more to the land.

3567, 3568. 3965-3968. 3999. 4003. Dwelling-houses in the Metropolis and many parts of England have already been freed; which has caused the increased pollution of rivers. This latter evil is becoming worse every year in proportion to the adoption of a better water supply, of a more perfect system of house drainage, and the increase of the population.

2821. 2828. 2897. 2901. 2993-2996. 3191-3228. 3281-3285. 3462. 3464. 3467. 3472. 3474. 3503. 3533. 3832. 3839, 3840. 3864, 3865. 3876. 3963, Dr. Acland and other witnesses believe that rivers can be effectually freed from pollution only by extending the Local Government Act to entire watersheds; or rather, by establishing Boards somewhat similar to the present Local Boards of Towns, which should extend over the whole area of each Catchment Basin, instead of being restricted to the precincts of each town. These Watershed or Catchment Boards should, in the opinion of those witnesses, have

all the powers for this purpose which are now enjoyed by the Local Boards of 3964. 4014. 4021.
Towns; and they should be placed under the direct authority and supervision of 4078.
the Home Office. They furthermore hold that it should be the duty of the Home Secretary to see that the law, as to the pollution of streams, is strictly enforced by these Watershed Boards.

The Secretary of the Local Government Office, as well as Mr. Rawlinson 3858–3877. 3885–
the Inspecting Engineer, while concurring in the necessity of appointing a Board 3887. 3907. 3922. 3935–8. 3946–3950.
for each Catchment Basin, gave a decided opinion that the duty of the Watershed 4077.
Board should be merely to supervise the action of the Local Boards within their district, and enforce an obedience to the law in causing them to desist from polluting the streams; but that the necessary works should be carried out by the Local Boards alone.

We recommend that the important object of completely freeing the entire basins of rivers from pollution should be rendered possible by general legislative
enactment, enabling the inhabitants of such entire districts to adopt some con- 4098. 4185.
trolling power for that purpose; but it should include a provision for compelling Local Boards to render the sewage of their districts innocuous by application to the land for agricultural purposes. The case of the valley of the Thames (where the purification of the river, which has been sought by the expenditure of enormous sums, is, to a considerable extent, counteracted by the increased discharge of sewage from towns higher up the stream) requires special and immediate attention.

Before concluding the inquiry, your Committee received some evidence with regard to the measures now being carried out by the Metropolitan Board of Works for diverting the sewage of the Metropolis. This inquiry your Committee have been unable to complete.

14 *July* 1864.

PROCEEDINGS OF THE COMMITTEE.

Martis, 3° *die Maii,* 1864.

MEMBERS PRESENT:

Lord R. Montagu.
Lord Fermoy.
Mr. Walpole.
Sir William Russell.
Dr. Brady.
Mr. Leader.
Mr. Hibbert.
Mr. Caird.

Lord *R. Montagu* was called to the Chair.

The Committee deliberated.

[Adjourned to Wednesday next, at One o'clock.

Lunæ, 9° *die Maii,* 1864.

MEMBERS PRESENT:

Lord Robert Montagu, in the Chair.

Mr. Sclater-Booth.
Mr. Hibbert.
Dr. Brady.
Lord Fermoy.
Mr. Leader.
Mr. Tite.
Mr. Caird.
Mr. Bright.

Mr. *John Thwaites* and Mr. *Bazalgette* examined.

[Adjourned to Thursday next, at Twelve o'clock.

Jovis, 12° *die Maii,* 1864.

MEMBERS PRESENT:

Lord Robert Montagu, in the Chair.

Dr. Brady.
Mr. Hibbert.
Sir Joseph Paxton.
Mr. Tite.
Mr. Sclater-Booth.
Lord Fermoy.
Mr. North.
Sir William Russell.
Mr. Ferrand.
Mr. Leader.
Mr. Caird.
Mr. Bright.

Mr. *W. Napier,* Mr. *W. Hope,* and *G. L. Hemans,* examined.

[Adjourned to Monday, 23d May, at One o'clock.

Lunæ, 23° *die Maii*, 1864.

MEMBERS PRESENT:

Lord ROBERT MONTAGU, in the Chair.

Mr. Walpole.
Mr. F. North.
Sir Joseph Paxton.
Mr. Caird.
Mr. Leader.
Sir William Russell.
Dr. Brady.
Sir Frederic Smith.
Lord Fermoy.
Mr. Sclater-Booth.
Mr. Tite.

Mr. *George Hopkins* examined.

The Committee deliberated.

Mr. *George Hopkins* further examined.

Mr. *John James Moore*, Mr. *Charles H. C. Roberts*, Mr. *James Brunlees*, and Mr. *George Herbert Townsend*, examined.

[Adjourned to Thursday next, at Twelve o'clock.

Jovis, 26° *die Maii*, 1864.

MEMBERS PRESENT:

Lord ROBERT MONTAGU, in the Chair.

Sir William Russell.
Mr. Ferrand.
Mr. Hibbert.
Mr. Leader.
Sir Joseph Paxton.
Mr. F. North.
Mr. Tite.
Mr. Adderley.
Dr. Brady.
Lord Fermoy.
Mr. Sclater-Booth.

Sir *Charles Fox*, Mr. *Richard Smith*, and Mr. *George Shepherd*, examined.

[Adjourned to Monday next, at One o'clock.

Lunæ, 30° *die Maii*, 1864.

MEMBERS PRESENT:

Lord ROBERT MONTAGU, in the Chair.

Mr. Cowper.
Sir William Russell.
Mr. F. North.
Mr. Bright.
Mr. Leader.
Mr. Ferrand.
Mr. Hibbert.
Sir Joseph Paxton.
Mr. Sclater-Booth.
Mr. Adderley.
Mr. Tite.
Sir Frederic Smith.
Mr. Caird.

Mr. *Thomas Ellis* and Mr. *John Bowing* examined.

[Adjourned to Thursday next, at Twelve o'clock.

Jovis, 2° *die Junii*, 1864.

MEMBERS PRESENT:

Lord ROBERT MONTAGU, in the Chair.

Mr. F. North.
Mr. Caird.
Mr. Ferrand.
Mr. Hibbert.
Lord Fermoy.
Mr. Tite.
Sir William Russell.
Sir Joseph Paxton.
Mr. Leader.

Mr. *William West* and Mr. *Cuthbert Johnson* examined.

Mr. *Thomas Ellis* and Mr. *John Bowing* further examined.

[Adjourned to Monday next, at One o'clock.

Lunæ, 6° *die Junii*, 1864.

MEMBERS PRESENT:

Lord ROBERT MONTAGU, in the Chair.

Mr. Hibbert.
Mr. Ferrand.
Sir William Russell.
Mr. Leader.
Mr. Tite.
Dr. Brady.
Mr. Caird.
Mr. Adderley.

Mr. *John Frederic Bateman*, Mr. *Arthur Whitehead*, and Mr. *William J. Ffennell*, examined.

[Adjourned to Thursday next, at Twelve o'clock.

Jovis, 19° *die Junii*, 1864.

MEMBERS PRESENT:

Lord ROBERT MONTAGU, in the Chair.

Mr. Ferrand.
Mr. Tite.
Mr. F. North.
Sir William Russell.
Mr. Adderley.
Mr. Leader.
Sir Frederic Smith.
Mr. Cowper.

Mr. *Samuel H. Gael* and Mr. Alderman *Mechi* examined.

[Adjourned till Monday, at One o'clock.

Lunæ, 13° *die Junii*, 1864.

MEMBERS PRESENT:

Lord ROBERT MONTAGU, in the Chair.

Mr. Adderley.
Mr. Leader.
Mr. Hibbert.
Sir Joseph Paxton.
Mr. Caird.
Sir Frederic Smith.
Mr. Sclater-Booth.
Mr. Ferrand.

Dr. *Acland*, Mr. *G. H. Walker*, and Mr. *Dale*, examined.

[Adjourned to Thursday next, at One o'clock.

Jovis, 16° *die Junii*, 1864.

MEMBERS PRESENT:

Lord ROBERT MONTAGU, in the Chair.

Mr. F. North.
Mr. Cowper.
Mr. Ferrand.
Mr. Hibbert.
Dr. Brady.
Sir Joseph Paxton.
Mr. Adderley.
Mr. Sclater-Booth.
Mr. Leader.
Sir William Russell.
Mr. Bright.
Mr. Caird.
Mr. Tite.

Mr. *Tom Taylor* and Mr. *Robert Rawlinson* examined.

[Adjourned till Monday, at One o'clock.

Lunæ, 20° *die Junii*, 1864.

MEMBERS PRESENT:

Lord ROBERT MONTAGU, in the Chair.

Mr. Tite.
Mr. Ferrand.
Mr. Sclater-Booth.
Sir Joseph Paxton.
Mr. Caird.
Mr. Bright.
Mr. Leader.
Lord Fermoy.

Mr. *Craven* and Mr. *Lawes* examined.

[Adjourned till Thursday next, at Twelve o'clock.

Jovis, 23° *die Junii*, 1864.

MEMBERS PRESENT:

Lord ROBERT MONTAGU, in the Chair.

Mr. Tite.
Mr. Ferrand.
Mr. Hibbert.
Sir Joseph Paxton.
Mr. Caird.
Mr. F. North.
Mr. Sclater-Booth.
Sir. William Russell.
Mr. Leader.

Professor *Way* and Mr. *Samuel Brirey Congreve* examined.

[Adjourned till Monday next, at One o'clock.

Lunæ 27° *die Junii*, 1864.

MEMBERS PRESENT:

Lord ROBERT MONTAGU, in the Chair.

Mr. Tite.	Mr. Leader.
Mr. Ferrand.	Sir Frederic Smith.
Dr. Brady.	Mr. Sclater-Booth.
Mr. Caird.	Sir William Russell.

Mr. *Bazalgette* examined.

[Adjourned till Thursday, at Twelve o'clock.

Jovis, 30° *die Junii*, 1864.

MEMBERS PRESENT:

Lord ROBERT MONTAGU, in the Chair.

Mr. Tite.	Mr. Leader.
Mr. Ferrand.	Sir Joseph Paxton.
Mr. Hibbert.	Mr. Cowper.
Mr. Caird.	Lord Fermoy.
Mr. F. North.	Sir Frederic Smith.

W. M'Cormick, Esq. (a Member of the House), Mr. *Ridley*, Mr. *Clever*, Mr. *Roach*, and Mr. *Nicholay*, examined.

The Committee deliberated.

Motion made, and Question proposed, "That the evidence be now closed"—(Mr. *Leader*).—Amendment proposed, to leave out from the word "that" to the end of the Question, in order to add the words, "evidence having been given before this Committee, making grave charges against the Metropolitan Board, it is the duty of this Committee to hear the Chairman of the Board in explanation of those charges"—(Mr. *Tite*)—instead thereof."—Question, That the words proposed to be left out stand part of the Question—put, and negatived.—Words added.—Main Question, as amended, put, and *agreed to.*

Mr. *Bazalgette* examined in explanation of his previous evidence.

[Adjourned to Monday next, at One o'clock.

Lunæ, 4° *die Julii*, 1864.

MEMBERS PRESENT:

Lord ROBERT MONTAGU, in the Chair.

Mr. Tite.	Lord Fermoy.
Mr. Sclater-Booth.	Sir William Russell.
Mr. Ferrand.	Mr. F. North.
Mr. Hibbert.	Sir Joseph Paxton.
Mr. Cowper.	Mr. Leader.

Mr. *Thwaites* examined.

Question,—

Room cleared, and Committee deliberated.

Motion made, and Question proposed, "That the Chairman of the Metropolitan Board of Works be not required to give evidence as to any matters which were confidentially communicated to the Board"—(Mr. *North*).—Amendment proposed, to leave out from the word "that" to the end of the Question, in order to add the words "the question as to why Mr. Ridley's contract was refused be pressed," instead thereof — (Lord *Fermoy*).—Question put, "That the words proposed to be left out stand part of the Question:—The Committee divided:

Ayes, 5.
Mr. F. North.
Sir William Russell.
Mr. Cowper.
Mr. Tite.
Mr. Sclater-Booth.

Noes, 4.
Lord Fermoy.
Mr. Ferrand.
Mr. Hibbert.
Sir Joseph Paxton.
Sir W. Russell.

Motion made, and Question proposed, "That the Committee having, by the following Resolution, declined to put the Question as to why Mr. Ridley's contract was rejected, Resolved, that we now close the hearing of further evidence"—(Lord *Fermoy*)—Committee divided:

Ayes, 6.
Mr. F. North.
Sir William Russell.
Lord Fermoy.
Mr. Leader.
Mr. Ferrand.
Mr. Hibbert.

Noes, 4.
Mr. Cowper.
Mr. Tite.
Mr. Sclater-Booth.
Sir Joseph Paxton.

Parties called in, and informed of the decision of the Committee.

[Adjourned till Monday next, at One o'clock.

Lunæ, 11° *die Julii*, 1864.

MEMBERS PRESENT:

Lord ROBERT MONTAGU, in the Chair.

Sir Joseph Paxton.
Mr. Tite.
Mr. Adderley.
Dr. Brady.
Mr. Hibbert.
Mr. Ferrand.
Mr. Cowper.

Lord Fermoy.
Mr. Leader.
Mr. Caird.
Mr. Bright.
Mr. F. North.
Mr. Sclater-Booth.
Sir W. Russell.

Motion made, and Question proposed, "That when the Report of the Committee is presented to the House, the entire evidence be reported therewith"—(Mr. *Ferrand*).—Amendment proposed, at the end of the Question, to add the words, "except with reference to the evidence containing the charges against the Metropolitan Board, because the reply of the Board of Works through their Chairman has not been heard. Nor is the evidence of Mr. Bazalgette, their engineer (put in, in writing, on Monday last), in the hands of the Committee"—(Mr. *Tite*).—Question put, That those words be there added:—The Committee divided:

Ayes, 3.
Sir Joseph Paxton.
Mr. Tite.
Mr. Adderley.

Noes, 10.
Dr. Brady.
Mr. Hibbert.
Mr. Ferrand.
Mr. Cowper.
Lord Fermoy.
Mr. Leader.
Mr. Caird.
Mr. Bright.
Mr. F. North.
Mr. Sclater-Booth.

Main Question put:—The Committee divided:

Ayes, 12.
Sir Joseph Paxton.
Mr. Adderley.
Dr. Brady.
Mr. Hibbert.
Mr. Ferrand.
Mr. Cowper.
Lord Fermoy.
Mr. Leader.
Mr. Caird.
Mr. Bright.
Mr. F. North.
Mr. Booth.

Noe, 1.
Mr. Tite.

Draft Report proposed by the *Chairman*, read 1°.

"1. Your Committee commenced their inquiry by examining into all those plans for utilising, in a liquid state, the sewage of the Metropolis which had been laid before the Metropolitan Board of Works, and were referred to the Committee by an Order of the House.

"2. Your Committee have also ascertained from Cornish engineers, of the greatest reputation, the prices of the steam engines and pumps which would be required to raise various quantities of sewage to stated heights.

"3. Mr. Bateman, the well-known water engineer, was examined as to the prices of the mains and pipes which would be necessary for the conveyance and distribution of sewage over land, and the estimated cost of laying them down and jointing them.

1778–1784. 2398, 2839, 2840. 2879. 2885. 3350–3352. 3392, 3393. 3411. 3413. 3436–3441. 3617–3619. 3714. 3769. 4072–4078, 4090, 4093. 4106. 4180–4183. 4191. 4194. 4195.

"4. Your Committee has come to the conclusion that it is not only possible to utilize the sewage of the Metropolis and of other towns, by conveying it in a liquid state through mains and pipes to the country, but that such an undertaking would result in pecuniary benefit to the ratepayers of the towns whose sewage is thus utilized.

"5. That benefit may, in a few years, be greatly increased; for, as Professor Way stated in his evidence, the amount of artificial manures is even at present insufficient, and the sources whence they are obtained will, in a few years, be exhausted. It is therefore absolutely necessary that other means of fertilising the land should be resorted to. 4785–4789. 4963–4968.

2357. 4102.

"6. The only obstacle to deter persons from undertaking the works necessary for this purpose, is the doubt whether farmers and landowners are sensible of the value of sewage, and would at once contract to take regular supplies of it to manure their land.

3843. 3844. 3972.

"7. This consideration could not, however, be a hindrance to the utilisation of sewage, except as a commercial speculation. It could not deter a local Board, whose object was merely to free rivers from pollution, and to increase the health of the population.

"8. There can be no doubt as to the amount of injury which results from the practice of conducting sewage and other refuse matters into the rivers, from whence numerous towns derive their water-supply.

2815, 2816. 2720–2723. 2772, 2773. 3728, 3729. 3812. 3817. 3823. 3969. 4017, 4018. 4034. 4708. 4741–4743.

"9. It is imperatively necessary that such a practice should be discontinued. The contamination of rivers ought to be put down by stringent enactments of the Legislature; for no really efficient method has been discovered to purify, for drinking and culinary purposes, water which has been once infected by town sewage. Filtration is ineffective for the attainment of this end. By no chemical means can such water be more than partially cleansed; it is always liable to putrify again. Processes of filtering and deodorization cannot, therefore, be relied upon to do more than mitigate the evil. Water which appears perfectly pure to the eye is sufficient, under certain conditions, to breed serious epidemics in the population which drinks it.

2226. 2825–2827. 2830. 3554. 3749, 3750. 3795. 4021, 4022. 4641–4644. 4728–4738.

"10. Fertile soils, however, and the roots of growing plants, have a wonderfully great and rapid power of completely abstracting all impurities from sewage water, and rendering it again perfectly innocuous and free from contamination.

3450–3455. 3457. 3530. 3552. 3593.
2848–2850. 2923–2934. 2987. 3483.

"11. The practice of conducting sewage into rivers is not only baneful to the health of the population, but is also injurious to the welfare of the country. Mr. Ffennell, the Chief Inspector of Fisheries, stated in his evidence that sewage water, in a putrifying state, is utterly destructive to fish; and that, if it were not for the polluted condition of the Thames, a very large revenue would be annually derived from the salmon which it would contain. An enormous increase in the amount of food for the people, and of revenue to the owners of rivers, would, therefore, result from purifying the rivers of the United Kingdom, which are now contaminated by sewage and other matters.

"12. The remedy for the pollution of water by mines and factories is neither costly nor difficult. It is, however, a graver question, in what way the contamination of rivers by town sewage should be prevented.

2825. 2826. 3820. 3823. 3497, 3498. 3606. 3845. 3848. 3953. 3968–3975. 4100. 4709. 4711. 4754.
2222. 2389. 2986. 3079, 3080. 3098. 3100. 3811. 3814, 3815.

"13. If the sewage of towns is no longer to flow into rivers, the only alternative which remains is to dispose of it on the land. The works which would be necessary for carrying out the latter object would at first be expensive, but might ultimately be remunerative. The former course is a violation of the law, and most injurious to the health and wealth of the population.

2947–2949. 2986–2991. 3172. 3176–3179. 3235–3239. 3248. 3308–3311. 3479. 3582. 3853–3857. 4009. 4264. 4268, 4269. 4283–4293.

"14. Mr. Gael stated, in his most valuable evidence, that it is undoubtedly contrary to common law, to permit any sewage to flow into a river. Yet the law, although explicit on this point, is nevertheless inoperative, because there is no authority whose province it is to enforce a strict obedience to its requirements.

3068–3070. 3074, 3075. 3491.
3075–3091. 3096–3099.

"15. From time immemorial, until within the last 30 years, it has been the custom to utilize all the nightsoil and other refuse on the land. Great obstructions used to be thrown in the way of making house drains which should empty themselves into the street sewers. The use of the latter was confined to the conveyance of the surface waters of the town.

There was a service of scavengers whose duty it was to remove excrementitious matters in their carts. And it was the office of the mayors of towns to take care that rivers, streams, and ponds were kept free from all noxious or filthy substances. But when the modern water-closets came into vogue, and the practice was introduced of flushing house-drains into the sewers, then the diluted nightsoil first began to find its way into rivers. 3134. 3847. 4010–4012. 4170, 4171.

“16. Yet the removal of house refuse to the land would now be much easier and cheaper than it was formerly; because carriage by suspension in a liquid is the cheapest mode of transport. 2163–2174. 3493. 4073–4078. 4101.

“17. In many towns of Lancashire there are to this day numerous cesspools. This is the case with Manchester; where the local authorities expend about 20,000 *l.* a-year for emptying them, and removing the contents to the land. A system of sewerage, and the necessary works to remove all the refuse in a liquid state to the adjacent fields, would thus cause a saving to the town. 4095, 4096. 4191. 4194, 4195.

“18. The Commissioners of Sewers and the Board of Health winked at the introduction of the practice of flushing the refuse of houses into the street sewers, and thence into the rivers. For they were of opinion that no time should be lost in freeing habitations from the dangerous infection of putrifying substances; and assumed that when this more pressing object had been accomplished, the law would be again respected, and measures would be taken to free the rivers and restore the refuse once more to the land. 3136–3142. 3151, 3152. 3157. 3180–3182. 3846.

“19. Dwelling-houses in most parts of England have already been freed; but the rivers are still polluted. This latter evil is becoming worse every year, in proportion to the more complete adoption of a better water supply, and of a more perfect system of house drainage. 3567, 3568. 3965–3968. 3999. 4003.

“20. Mr. Gael strongly asserted that the necessity of freeing rivers from every kind of pollution, and of guarding the water supply of towns from infectious matters, demands the immediate and serious attention of the Legislature. 3833.

“21. In common with Dr. Acland and other witnesses, he believes that this object could be best attained by extending the Local Government Act to entire watersheds; or rather, by establishing Boards somewhat similar to the present Local Boards of Towns, which should extend over the whole area of each Catchment Basin, instead of being restricted to the precincts of each town. These Watershed or Catchment Boards should, in the opinion of those witnesses, have all the powers which are now enjoyed by the Local Boards of Towns; and they should be placed under the direct authority and supervision of the Home Office. It should, furthermore, be the duty of the Home Secretary to see that the law, as to the pollution of streams, is strictly enforced by these Watershed Boards. 2821. 2828. 2897. 2901. 2993–2996. 3191–3228. 3281–3285. 3462. 3464. 3467. 3472. 3474. 3503. 3533. 3832. 3839, 3840. 3864, 3865. 3876. 3963, 3964. 4014. 4021. 4078.

“22. Mr. Tom Taylor, on the other hand, while concurring in the necessity of appointing a Board for each Catchment Basin, with compulsory powers to enter upon land, in order to carry out their works, differed in the following respects:—Mr. Tom Taylor, as well as Mr. Rawlinson, gave a decided opinion that the duty of the Watershed Board should be merely to supervise the action of the Local Boards in the several towns, and enforce an obedience to the law, in causing them to desist from polluting the streams; but that the necessary works should be carried out by the Local Boards alone. Mr. Taylor also objected strongly to the proposal of the former witnesses, in that a central authority would thus be placed over the Local Boards of the country. 3858–3877. 3885–3887. 3907. 3922. 3935–8. 3946–3950. 4077.

“23. We hesitate, however, to recommend that this object should be carried out by a general legislative enactment, which should apply to the whole of England, until the country has become fully sensible of the benefits which will accrue from the utilisation of sewage. To force the Local Board of a town to desist from polluting its river, might induce them to retain their fœcal matter in the dwelling-houses, rather than incur the expense of erecting works to utilise it. Still more might those towns, which are not yet supplied with water-closets, be induced, by pecuniary motives, to hesitate in getting rid of their cesspools, and substituting a proper system of sewers. 4098. 4185.

“24. The purification of streams, consequent upon the general utilisation of sewage, will depend primarily on commercial principles; for, if it be once fully sstablished that sewage is a valuable manure, and can be profitably utilised on land, commercial enterprise would render Parliamentary action unnecessary.

“25. Two methods may be suggested, by which the benefit of utilising sewage may be demonstrated to the country:

“First. That some town should be selected, and its sewage utilised, under the direction of disinterested persons. There might, however, be some difficulty in selecting a town which would be willing to undertake the expenses necessary for carrying out, in detail, a number of extensive experiments for the benefit of the whole country. To give weight and authority to such experiments, they should be entrusted to persons whose interests would not, in any way, be benefited or injured by the general utilisation of the sewage of towns. Experiments on such a large scale would, moreover, extend over many years. During this time, the sewage of our towns would be lost, while the public health would suffer injury from the continued pollution of our streams.

"26. The second method is, that one of the gentlemen, whose schemes have been examined by your Committee, should be allowed to bring the question before Parliament. When applying for an Act to enable him to utilise the sewage of the Metropolis, it would be necessary for him to produce, before a Private Bill Committee of this House, complete and convincing evidence as to the results which have already been obtained from sewage, and the efficiency of the means which he proposes for utilising it.

"27. Your Committee are of opinion that by this means the country at large would be enabled to arrive more quickly at correct opinions upon this great subject than by instituting any number of desultory experiments.

"28. Mr. Ellis has offered to bring such an inquiry before Parliament, and to produce, at his own cost, all the necessary proofs of the value of sewage, and the practicability of his scheme. He has undertaken not to ask the public to subscribe towards his capital until he has established his case, and obtained the necessary Act of Parliament, provided he receives a conditional concession of the sewage, to justify him in going to such an expense.

"29. Your Committee are therefore of opinion, that the interests of the country would be best advanced by accepting such an advantageous proposition. An inquiry so conducted, even if it prove unsuccessful, will not have endangered the interests of the public, while, if successful, it would set at rest the important question of how the sewage of towns can be profitably utilised, and the rivers freed from the gravest sources of pollution.

"30. Before concluding the inquiry, your Committee received some evidence with regard to the measures now being carried out by the Metropolitan Board of Works for diverting the sewage of the Metropolis. This inquiry your Committee have been unable to complete; we are, however, of opinion that, as circumstances have been mentioned to us which seem to inculpate the Metropolitan Board, a more prolonged and searching investigation would be necessary, in order that a just conclusion might be arrived at. No unnecessary delay should be incurred in commencing that investigation; and we recommend that, until it is completed, no further works should be undertaken by the Metropolitan Board."

Draft Report proposed by Mr. *Caird*, read 1°.

"Report—

"1. That, after some inquiry into the plans for utilising the sewage of the Metropolis, which had been laid before the Metropolitan Board of Works, your Committee took evidence regarding the pumping, conveyance, and distribution over the land of sewage in the liquid state, and as to its value as a manure.

"2. The evidence laid before your Committee has led them to the conclusion—

"(1.) That the value of town sewage as manure is regulated entirely by its proportion of dilution to the numbers of the population, that value being greatest where the dilution is smallest.

"(2.) That the manure which the sewage contains can be applied in the cheapest manner when conveyed in suspension in water.

"(3.) That in the liquid state sewage may be most profitably used for the production of grasses, whether natural or artificial.

"(4.) That sewage, when so applied, even in considerable quantities to growing grass, occasions little or no nuisance when spread thinly over the ground, and that by a simple process of deodorization it may, if necessary, be completely deprived of smell.

"(5.) That the cost of its application depends on the proximity and elevation of the lands to which it is to be applied, that cost being least where the situation of the land admits of the transmission of sewage by natural gravitation.

"(6.) That, in its most common state, town sewage is so largely diluted with water, that, to produce profitable results, heavy applications of it are requisite.

"(7.) That the soils best adapted for its use are those of a very porous character, whether sand or loam, which admit of its ready absorption.

"(8.) That your Committee are satisfied that there is now sufficient proof, by the evidence adduced before this and a former Committee, and the numerous examples in operation, both of the mode by which sewage may be advantageously applied to land, and of the ultimate profit to be derived by all parties from its judicious use.

"(9.) Your Committee, having examined the Chairman and Engineer of the Metropolitan Board of Works, are of opinion that more might have been done by that Board towards the profitable use of the sewage of London; and that the completion of the outfall sewerage of the Metropolis ought, at the earliest possible moment, to be followed by the adoption of a system which may convert that sewage from a nuisance into a permanent and increasing source of agricultural fertility.

"(10.) That Your Committee are of opinion that the peculiar circumstances of each city or town will necessarily guide them in the adoption of such plans as are most suitable to each; but Your Committee desire to repeat the recommendation of Your Committee on the same subject in 1862, that the municipal authorities should have certain powers to enable them to rent, or otherwise deal with lands in their neighbourhood, for the most profitable application of the sewage, in relief of local taxation.

"3. Your Committee examined several witnesses regarding the pollution of the rivers and streams of the country.

"4. The effects of such pollution are mainly dependent on the volume of water with which the offensive matter becomes diluted.

"5. That offensive matter consists of the sewage of towns, and, in the manufacturing and mining districts, also of the refuse from factories, dye works, gas works, foundries, mills, and other establishments, and of masses of rubbish of every kind which are thrown upon the river banks, and obstruct their beds, and impede the current of the waters.

"6. That this pollution and obstruction is rapidly increasing, and has become, in certain localities, a public, as it may soon be a national nuisance, interfering with the convenience and comfort of the people, and likely to endanger the public health, while it is also seriously injurious to river fish.

"7. That the pollution caused by sewage is most effectually corrected by passing the sewage through porous soil covered with vegetation; and that thus the utilisation of sewage is at the same time the best mode of rendering it innocuous to health.

"8. Your Committee are of opinion that the pollution of rivers demands the early attention of the Legislature, and the adoption of such measures as may confer a general jurisdiction over the whole area of each catchment basin; so that there may be sufficient powers for the regulation of all public and private water rights, for the purpose of putting a stop to such pollution and obstruction as may be found injurious to the general welfare.

"9. Your Committee received some evidence with regard to the works for the disposal of the sewage of the Metropolis, now being carried out by the Metropolitan Board of Works. But as it seemed likely to involve other questions which, however proper for Parliamentary inquiry, were not included in the order of reference, Your Committee declined to proceed further in that inquiry."

Motion made, and Question proposed, "That the Draft Report proposed by the Chairman be now read 2°, and considered, paragraph by paragraph."—Amendment proposed, to leave out the words "the Chairman," in order to insert the words "Mr. Caird," instead thereof—(Mr. *Caird*).—Question, That the words "the Chairman" stand part of the Question.—The Committee divided:

Ayes, 9.	Noes, 6.
Mr. Cowper.	Mr. Bright.
Mr. Adderley.	Sir William Russell.
Sir Frederic Smith.	Mr. Caird.
Lord Fermoy.	Mr. Tite.
Sir Joseph Paxton.	Mr. Sclater-Booth.
Mr. Leader.	Mr. F. North.
Mr. Hibbert.	
Dr. Brady.	
Mr. Ferrand.	

Main Question put, and agreed to.

Report considered, paragraph by paragraph.

Paragraphs 1, 2, 3, *agreed to.*

Paragraph 4 read.—Amendment proposed, to leave out the words, "the Metropolis and of other"—(Mr. *Cowper*).—Question put, That the words proposed to be left out stand part of the paragraph.—The Committee divided:

Ayes, 5.	Noes, 8.
Mr. Adderley.	Mr. Cowper.
Lord Fermoy.	Mr. Bright.
Sir Joseph Paxton.	Sir William Russell.
Mr. Tite.	Sir Frederic Smith.
Dr. Brady.	Mr. Caird.
	Mr. Hibbert.
	Mr. F. North.
	Mr. Ferrand.

Amendment proposed at the end of the paragraph, to add the words, "At the same time, the failure of the experiments at Rugby, and the strong opinions expressed by Mr.

Rawlinson, the Government Engineer, cannot be overlooked"—(Mr. *Tite*).—Question, That those words be there added, put, and *negatived.*

Paragraph 5 amended, and *agreed to.*

Paragraphs 6 and 7, *negatived.*

Amendment proposed, after Paragraph 7 to insert the following paragraph:—"Your Committee, having examined the Chairman and Engineer of the Metropolitan Board of Works, are of opinion that more might have been done by that Board towards the profitable use of the sewage of London; and that the completion of the outfall sewerage of the Metropolis ought, at the earliest possible moment, to be followed by the adoption of a system which may convert that sewage from a nuisance into a permanent and increasing source of agricultural fertility"—(Mr. *Caird*).—Amendment proposed, to omit from the words "Your Committee" to the word "London"—(Mr. *Tite*).—Question put, That the words proposed to be left out stand part of the paragraph.—The Committee divided:

Ayes, 8.	Noes, 6.
Mr. Cowper.	Mr. Bright.
Sir Frederic Smith.	Mr. Adderley.
Sir Joseph Paxton.	Sir William Russell.
Mr. Caird.	Lord Fermoy.
Mr. Leader.	Mr. Tite.
Mr. Hibbert.	Mr. F. North.
Dr. Brady.	
Mr. Ferrand.	

Paragraph *agreed to,* and inserted in the proposed Report.

3843. 3844. 3972. Amendment proposed, after the last paragraph to insert the words:—"Even if a pecuniary benefit were not to be secured, yet such a consideration should not deter local authorities from taking such steps as are possible to free rivers from pollution"—(*The Chairman*).—Question, That those words be there inserted, put, and *agreed to.*

Amendment proposed, to insert the words:—"Your Committee examined several witnesses regarding the pollution of the rivers and streams of the country"—(Mr. *Caird*).—Question, That those words be there inserted, put, and *agreed to.*

Paragraph 8 amended, and *agreed to.*

Amendment proposed, to insert the words:—"The injurious effects of such pollution are mainly dependent on the volume of water with which the offensive matter becomes diluted"—(Mr. *Caird*).—Question put, That those words be there inserted.—The Committee divided:

Ayes, 6.	Noes, 6.
Mr. Cowper.	Mr. Adderley.
Sir William Russell.	Sir Frederic Smith.
Sir Joseph Paxton.	Mr. Leader.
Mr. Caird.	Mr. Hibbert.
Mr. Tite.	Dr. Brady.
Mr. F. North.	Mr. Ferrand.

Whereupon, the Chairman declared himself with the Noes.

Paragraph 9.—Amendment proposed, to leave out the words, "The contamination of rivers ought to be put down by stringent enactments of the Legislature"—(Mr. *Adderley*).—Question, That the words proposed to be left out stand part of the paragraph, put, and *negatived.*

Amendment proposed, to leave out from the words "By no chemical means" to the end of the paragraph—(Mr. *Cowper*).—Question put, That the words proposed to be left out stand part of the paragraph.—The Committee divided:

Ayes, 6.	Noes, 6.
Sir Frederic Smith.	Mr. Cowper.
Lord Fermoy.	Mr. Adderley.
Sir Joseph Paxton.	Mr. Caird.
Mr. Tite.	Dr. Brady.
Mr. Leader.	Mr. F. North.
Mr. Hibbert.	Mr. Ferrand.

Whereupon, the Chairman declared himself with the Ayes.

Paragraph, as amended, *agreed to.*

Paragraph 10 amended, and *agreed to.*

Paragraph 11.—Amendment proposed, to leave out the two first lines of the paragraph.—Question, That the words proposed to be left out stand part of the paragraph, put, and *negatived.*

Another amendment proposed, to leave out the word "destructive," in order to insert the word "injurious"—(Mr. *Cowper*)—instead thereof.—Question put, That the word "destructive" stand part of the paragraph.—The Committee divided:

Ayes, 7.
Mr. Adderley.
Lord Fermoy.
Mr. Leader.
Mr. Hibbert.
Dr. Brady.
Mr. F. North.
Mr. Ferrand.

Noes, 5.
Mr. Cowper.
Sir Frederic Smith.
Sir Joseph Paxton.
Mr. Caird.
Mr. Tite.

Another amendment proposed, to leave out from the words "and that if" to the word "contain"—(Mr. *Cowper*).—Question put, That the words proposed to be left out stand part of the paragraph.—The Committee divided:

Ayes, 5.
Mr. Adderley.
Sir Frederic Smith.
Lord Fermoy.
Dr. Brady.
Mr. Ferrand.

Noes, 7.
Mr. Cowper.
Sir Joseph Paxton.
Mr. Caird.
Mr. Tite.
Mr. Leader.
Mr. Hibbert.
Mr. F. North.

Question, That this paragraph, as amended, stand part of the proposed Report,—put, and agreed to.

Paragraph 12.—Question put, That this paragraph stand part of the proposed Report.—The Committee divided:

Ayes, 5.
Lord Fermoy.
Mr. Tite.
Mr. F. North.
Mr. Ferrand.
Mr. Sclater-Booth.

Noes, 7.
Mr. Cowper.
Mr. Adderley.
Sir Frederic Smith.
Mr. Caird.
Mr. Hibbert.
Dr. Brady.
Sir Joseph Paxton.

Paragraph 13.—Amendment proposed, to leave out from the word "land" to the end of the paragraph—(Mr. *Adderley*).—Question put, That the words proposed to be left out stand part of the paragraph.—The Committee divided:

Ayes, 5.
Lord Fermoy.
Mr. Tite.
Dr. Brady.
Mr. F. North.
Mr. Ferrand.

Noes, 7.
Mr. Cowper.
Mr. Adderley.
Sir Frederic Smith.
Sir Joseph Paxton.
Mr. Caird.
Mr. Hibbert.
Mr. Sclater-Booth.

Question, That this paragraph, as amended, stand part of the proposed Report,—put, and *agreed to.*

Paragraph 14 amended, and *agreed to.*

[Adjourned till Thursday, at Twelve o'clock.

Jovis, 14° *die Julii*, 1864.

MEMBERS PRESENT:

Lord ROBERT MONTAGU, in the Chair.

Mr. Tite.
Mr. Ferrand.
Dr. Brady.
Sir Joseph Paxton.
Sir William Russell.

Mr. Adderley.
Lord Fermoy.
Mr. North.
Mr. Cowper.
Mr. Sclater-Booth.

Paragraph 15, amended, and *agreed to.*

Paragraph 16, *agreed to.*

Paragraphs 17, 18, and 19, amended, and *agreed to.*

Paragraph 20, *negatived.*

Paragraphs 21 and 22, amended, and *agreed to.*

Paragraph 23.—Amendment proposed, to leave out from the word "we" to the end of the paragraph, in order to insert the words "recommend that the important object of completely freeing the entire basins of rivers from pollution should be rendered possible, by general legislative enactment, enabling the inhabitants of such entire districts to adopt some controlling power for that purpose"—(Mr. *Adderley*)—instead thereof.—Question, That the words proposed to be left out stand part of the paragraph, put, and negatived. —Question, That those words be there added, put, and *agreed to.*

Another amendment proposed to the paragraph, by adding after the word "purpose" the words "but it should include a provision for compelling local Boards to render the sewage of their districts innocuous by application to the land for agricultural purposes" —(Mr. *Cowper*).—Question, That those words be there added, put, and *agreed to.*

4098. 4185. Another amendment proposed to the proposed paragraph, by adding after the word "purposes" the words, "the case of the valley of the Thames (where the purification of the river, which has been sought by the expenditure of enormous sums, is to a considerable extent counteracted by the increased discharge of sewage from towns higher up the stream), requires special and immediate attention"—(Mr. *Cowper.*)—Question put, That those words be there added.—The Committee divided:

Ayes, 9.
Mr. Tite.
Mr. Ferrand.
Dr. Brady.
Mr. Cowper.
Lord Fermoy.
Sir William Russell.
Mr. Adderley.
Mr. F. North.
Mr. Sclater-Booth.

Noe, 1.
Sir Joseph Paxton.

Question, That this paragraph, as amended, stand part of the proposed Report,—put, and *agreed to.*

Paragraphs 24, 25, 26 and 27, *negatived.*

Paragraph 28.—Question put, That this paragraph stand part of the proposed Report. —The Committee divided:

Aye, 1.
Dr. Brady.

Noes, 9.
Mr. Tite.
Mr. Ferrand.
Sir Joseph Paxton.
Mr. Cowper.
Lord Fermoy.
Sir William Russell.
Mr. Adderley.
Mr. F. North.
Mr. Sclater-Booth.

Paragraph 29.—Motion made, and Question proposed, That this paragraph stand part of the proposed Report.—Amendment proposed, to leave out from the word "your" to the end of the paragraph, in order to insert the words "Committee recommend that a further examination into all the plans for utilising the sewage of the metropolis should be carried out under the control of some Body more responsible to Parliament than the Metropolitan Board of Works"—(Dr. *Brady*)—instead thereof.—Question, That the words proposed to be left out stand part of the paragraph, put, and *agreed to.*—Question, That paragraph 29 stand part of the propcsed Report,—put, and *negatived.*

Question put, That those words be there added.—The Committee divided:

Ayes, 3.
Mr. Ferrand.
Dr. Brady.
Lord Fermoy.

Noes, 7.
Mr. Tite.
Sir Joseph Paxton.
Mr. Cowper.
Sir William Russell.
Mr. Adderley.
Mr. F. North.
Mr. Sclater-Booth.

Paragraph 30.—Amendment proposed, to leave out from the words "we are, however, of opinion that" to the end of the paragraph—(Mr. *Tite.*)—Question put, That the words proposed to be left out stand part of the paragraph.—The Committee divided:

Ayes, 4.	Noes, 6.
Mr. Ferrand.	Mr. Tite.
Dr. Brady.	Sir Joseph Paxton.
Mr. Cowper.	Sir William Russell.
Lord Fermoy.	Mr. Adderley.
	Mr. F. North.
	Mr. Sclater-Booth.

Question, That this paragraph, as amended, stand part of the proposed Report,—put, and *agreed to.*

Question, That this Report, as agreed to, be the Report of the Committee to the House,—put, and *agreed to.*

Ordered to Report, together with the Minutes of Evidence, and Appendix.

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Lunæ, 9° *die Maii*, 1864.

MEMBERS PRESENT:

Mr. Sclater-Booth.
Dr. Brady.
Mr. Bright.
Mr. Caird.
Lord Fermoy.
Mr. Hibbert.
Mr. Leader.
Lord R. Montagu.
Mr. Tite.

LORD ROBERT MONTAGU, IN THE CHAIR.

JOHN THWAITES, Esq., and JOSEPH WILLIAM BAZALGETTE, Esq., called in; and Examined.

J. Thwaites, Esq., and *J. W. Bazalgette*, Esq.

9 May 1864.

1. *Chairman.*] (To Mr. *Thwaites.*) YOU are the Chairman of the Metropolitan Board of Works, are you not?—Yes.

2. And you have been so since its formation?—Since 1855.

3. You are Chairman also of the Main Drainage Committee, are you not?—Yes.

4. Have you considered all the tenders for the utilisation of the sewage of the Metropolis?—Yes, we have considered them, and they are now under the consideration of the Committee.

5. They have been considered by you and Mr. Bazalgette, have they not?—Yes.

6. Can you explain those tenders to the Committee?—I can state the substance of them.

7. When did the Board first advertise for tenders for dealing with the sewage of the Metropolis?—On the 27th January, 1860.

8. And you advertised again upon the 13th of March, 1863, did you not?—The 6th of March, 1863.

9. And again in May, 1863?—On the 8th of May, extending the period for receiving the tenders.

10. In the advertisement of March there is a condition that all tenders must contain a full description of the works proposed, and must be accompanied by plans and sections showing their several details. In the case of the utilisation of sewage over a small area that might be easily done; but in the case of a large area would not those plans and details be very expensive?—No doubt, but still the principle could have been illustrated by plans for a small area.

11. But the cost of plans containing all the details over a large area would amount to many thousands of pounds, would it not?—Not necessarily so, because the same principle would apply to a larger area. The Board required to know the area on which they proposed to distribute the sewage and the principle of that distribution.

12. Those who tendered had also to state the quantity and the locality of the land over which the sewage is to be distributed, the points at which the sewage is to be intercepted, and so forth. Would not that also require a very expensive detail?—Not at all; a description of the land would be a very simple affair.

13. Even if the sewage were to be carried over a very large area, would that be the case?—Undoubtedly. The reason why that condition was inserted in the advertisement is because in the first Main Drainage Act, the 18th & 19th Vict., c. 120, s. 135, there are these words: "The said Board may cause the sewage and refuse from such sewers to be sold or disposed of as they may see fit, but so as not to create a nuisance.

14. Does that give you a power to sell it for ever?—I think so clearly. That clause says:—"The said Board may cause the sewage and refuse from such sewers to be sold or disposed of as they may see fit, but so as not to create a nuisance," and I take that in connexion with the 21st & 22nd of Vict., c. 104, s. 31, which reads thus,—"It shall be lawful for one of Her Majesty's Principal Secretaries of State, at his discretion, on representation or complaint made to him of any nuisance committed in execution of any works, or in deodorising any sewage, or in disposing of any sewage or refuse from sewers, or in any other manner under this Act, to cause inquiry to be made into the matter represented or complained of to him, and to direct such prosecution or prosecutions, or to take such other proceedings as he may think fit, in order to ensure the prevention or abatement of such nuisance as aforesaid." Having regard to the section in the 18th & 19th of Vict., and the section that I have just read the Board, I felt it incumbent upon them

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them to require from the parties some description of the area over which they proposed to distribute the sewage and also a general outline of the plan which they proposed to adopt in order that the Board themselves might be satisfied, they being responsible to the public, that no nuisance would result from the distribution.

15. There is a clause in the advertisement of the 11th of May 1863, which I should like you to explain. "In any contract provision must be made to secure to the Board the return of the sewage works, and the full power to re-let and deal with the same, and so that the Board may in case of any failure of the contractors or their operations be left to their full rights, and without any cost to the Board." Do you mean that if the sewage operations were considered to have failed, or to be a nuisance, the whole works would be delivered over to you free of cost?—That undoubtedly is what is indicated in that advertisement, for this reason, some company to whom the concession of the sewage might be made might proceed partially to develope their plan, failing to carry out the general principle of the utilisation of the sewage; and the Board having made a concession to that Company of the sewage, would not be in a position to deal with it and to dispose of it to any other party who had ability to carry out the arrangement.

16. Then do you mean that this clause refers merely to the sewage itself, but not to the works that have been raised?—That is a penalty upon the parties that they should carry out the plan which they have covenanted with the Board to carry out.

17. You mean that all engines and buildings and pipes are to revert to the Board in the case of the failure of the company?—It was assumed that a company A—— having obtained a concession of the sewage from the Board might fail at an early stage of their works to carry them out, that the Board having granted the concession their hands would be tied, and they would be unable to deal with any other party, and therefore to unlock their hands they have inserted this in the advertisement as a penalty against the non-fulfilment of the contract into which they enter.

18. If those works were very large and were to deal with the sewage over large areas, they would cost a very large sum of money, would they not?—No doubt.

19. How would the company raise the capital necessary to construct those works?—Of course company to whom the Board might grant the concession would be under a special agreement.

20. But how would the capital be raised—would it not be by subscription on the part of the public, that is, by shares being taken?—Probably it would.

21. Would not such a clause as this operate in a way hostile to the undertaking so as to prevent shares being subscribed for by the public?—Probably it might, but I am not prepared to say what the effect would be.

22. And the effect of the public not subscribing would be, would it not, that the company would be knocked on the head, and sewage would not be utilised?—Of course, if persons ask for the sewage, we presume that they have thoroughly investigated the question, and have measured their liability and their prospects of carrying out the undertaking, if so, there will be no fear whatever from the terms of the advertisement that they would have to sacrifice any portion of their plans.

23. Then it is to take place only in case of an actual failure or a break-down of the Company?—For example, a company some years ago had certain powers over sewers in a particular locality, and from time to time, when legislation was asked for, the powers and rights of that company were preserved. We felt it to be very inconvenient that any party should have a right which would prevent the Board from the disposing of the sewage in the best possible way.

24. The next clause in the advertisement says, "The tender must contain the names of two or more sureties, to be approved by the Board, who shall be jointly and severally bound in a competent sum for the due performance of the contract, and for the efficient execution of the works in accordance with the provisions and subject to the limitations of the Metropolitan Local Management and Main Drainage Acts." Now, if the works were undertaken by a company, they would have to be embodied under an Act of Parliament, would they not?—I should apprehend so.

25. Then, could not the Act of Parliament contain clauses and restrictions for the protection of the Board and of the ratepayers?—No doubt; but it is necessary in advertising for tenders, that we should intimate to parties who might apply for a concession, that they should give security.

26. Even though they might be embodied in an Act of Parliament?—No doubt; because they ask for a concession prior to obtaining an Act.

27. Then you do not think that those clauses would act as a hindrance to tenders being sent in?—I think not to parties who felt the correctness of their own principles.

28. Mr. *Caird.*] Are you clear that it requires an Act of Paliament to carry out that?—It would require an Act of Parliament, because they would have to convey their pipes through lands and along public roads, and obtain other powers which would be absolutely necessary.

29. *Chairman.*] There is the Report from your Main Drainage Committee, dated the 1st January 1862; you had by that time received certain tenders. Will you name the person from whom you received those tenders?—I have had a careful abstract made of the Minutes of the Board, and of the Committee, showing the action taken by the Board, and by the Committee.

30. I will read the names of the persons; the London Sewage Utilisation Company, Mr. John James Moore, Mr. George Shepherd, Mr. Charles F. Kirkman, Mr. Ellis, and the Honourable William Napier, and Mr. Hope; were those the names contained in this report?—That is so.

31. Had you any other tenders by that time which are not mentioned in this report?—I think not; there were communications of a vague character, which were not absolute tenders.

32. Now take them in order, if you please; did the London Sewage Utilisation Company propose to utilise the sewage in the liquid state?—Yes.

33. Did they furnish you with the details of their plans and the cost of their works, and the amount of working expenses?—I believe they did, to a certain extent.

34. Over what extent of area did they propose to distribute the sewage?—I do not remember at this moment.

35. Did they mention any area?—Probably they

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they did, but I have not the figures before me.

36. Would Mr. Bazalgette know that better?—Probably he may.

37. (To Mr. *Bazalgette.*) Can you answer that question?—I think it was from 15,000 to 20,000 acres.

38. You are the engineer to the Metropolitan Board of Works, are you not?—Yes.

39. And you reported on those tenders to the Main Drainage Committee?—No; I do not think I ever reported upon them.

40. Then what is your Report, No. 70?—That was upon a special tender.

41. Did you not report upon the others?—No.

42. Did the London Sewage Utilisation Company furnish details of their plans of the cost of the works and of the amount of working expenses?—They did, I think.

43. Could you not answer that question more definitely?—No; I am afraid not.

44. Over what area did they propose to utilise the sewage?—I think an area of about 20,000 acres.

45. What rent did they offer to the Board of Works for all the sewage?—The proposals of the London Sewage Utilisation Company were that the Board of Works should grant the Company as much sewage as they might require at Barking for two years, at a rent of 5 *l.*; that, should the experiment be successful, the Board should, at the end of those two years, grant a further term of 21 years at the same rent; and that at the end of such term the Company should pay such rent for such further term as might be agreed upon between the parties, or as might be determined by the President of the Institution of Civil Engineers, or by an arbitrator to be appointed by the Board of Trade.

46. Did they put in any maps with their tenders?—I think that they put in maps showing generally the district over which they proposed to distribute the sewage, but they had made no definite arrangements with that object.

47. (To Mr. *Thwaites.*) The next proposal was that of Mr. John James Moore; did he propose to utilise the sewage in a liquid state?—He did; he proposed taking the whole of the sewage for agricultural purposes for a term of 90 years, or other reasonable period, the Board receiving a nominal peppercorn rent for the first 14 years, and at the expiration of that time one-half of the profits from the sale of the sewage, after deducting 10 per cent. on account of the capital invested, or such reasonable return as may be awarded by arbitrators to be appointed by her Majesty's Secretary of State.

48. Did he furnish you with the estimate for the cost of his works and working expenses?—I do not remember at this moment whether he did or not without referring to the tender itself.

49. You do not know whether he complied with the conditions in your advertisement?—None of them complied with the conditions thoroughly.

50. Did he propose to utilise the sewage over lands in his own possession, or to let it to farmers?—I think he proposed to let it to farmers.

51. The next is Mr. George Shepherd; did he propose to utilise the sewage in a liquid form?—Yes; to take the sewage of London for agricultural purposes for a term of 50 years in the first instance, the Company to be entitled, out of the revenue arising from the sale of the sewage on all occasions to a preference of 7½ per cent. per annum on the capital employed; that all proceeds beyond such per-centage should be equally divided between them and the Board, and that, at the expiration of the 50 years, the Company should receive a preference of 5 per cent. on their capital, the surplus being divided as before.

52. Did he furnish you with details, plans, and estimates?—I think not.

53. Over what area did he propose to utilise the sewage?—I am not sure, but I think it was 300,000 acres.

54. Did he state any area?—I am not quite sure.

55. What was Mr. Kirkman's plan for utilising the sewage?—His plan was for deodorising and utilising the sewage to its fullest extent by solidifying it.

56. Did he furnish you with particulars?—He did, I believe, at a subsequent period.

57. What rent did he offer?—Mr. Kirkman's proposition embodies a patent, of which he is the patentee, for obtaining manure from sewage by filtration and deposit, the water, after such treatment, to be discharged into the river. He proposes to erect works for this purpose at Barking, on condition that the Board shall convey to him the necessary land adjoining the reservoir, shall deliver the sewage to him from the main outfall sewer into his works; shall grant him the use of their river frontage and wharves for the term of seven years at a peppercorn rent, seven years at a rent of one-fifth the net profits, after deducting a dividend of 20 *l.* per cent. on the capital expended, and for a further term of seven years at a rent of one-fifth the net profits after deducting 5 *l.* per cent on the capital, and for any further term at such rate as shall be settled by the Secretary of State. Mr. Kirkman states that he is prepared to guarantee a minimum rent of 10,000 *l.* per annum, and he undertakes to name two or more securities for the performance of the contract. He consents also to surrender the works on two years' notice, subject to the repayment of the capital invested, and of a premium of 25 *l.* per cent. thereon, and to a royalty of 1 *l.* per cent. for the use of his patent.

58. Are you of opinion that manure can be extracted and solidified from sewage with any chance of commercial profit?—I scarcely like to depreciate the article we have to dispose of.

59. Do you agree with the Commissioners of Sewage in saying that it could not?—I think that its application in a liquid form is more profitable.

60. Are you aware that Messrs. Hofmann and Witt, and Mr. Lawes, and the Commissioners have stated that it cannot be extracted a solid with any prospect of commercial profit?—Probably that is so.

61. Then the Board of Works would not get their 10,000 *l.* a year, would they?—Not from Mr. Kirkman.

62. Did Mr. Ellis propose to utilise the sewage in a liquid form?—He did.

63. Did he furnish you with details and estimates of the cost of his works and working expenses?—He did.

64. What was the extent of area over which he proposed to utilise it; was it over a very large area?—522,104 acres.

65. Did he propose to utilise it over lands in his own possession, or to let it to farmers?—To let it to farmers, I believe.

66. What rent did he offer?—He proposes to pump the sewerage in covered tanks constructed

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at such points as the Board may approve on the banks of the Thames.

67. But what rent does he propose to pay?—The net profits, deducting the working and management expenses and reserve fund, he proposes to divide equally between the Company and the Board.

68. What is the reserve fund?—It is not stated here.

69. Is it any sum of money that he specifies?—It is merely a reference to a reserve fund.

70. Did Messrs. Napier and Hope propose to utilise the sewage in a liquid state?—They did.

71. Did they furnish you with details and estimates?—They did.

72. They applied for the sewage only from the north side, did they not?—From the north side only.

73. Where did they propose to utilise that sewage?—At Maplin, on the coast of Essex.

74. Over what extent of area did they propose to utilise it?—I believe that they proposed to reclaim about 20,000 acres which are now partly submerged; and they proposed also to distribute from their main tunnel, which would be something like 44 miles in length right and left, as they had an opportunity.

75. What rent did they propose to pay for the sewage?—The net profits were to be divided equally between the Company and the Board after a deduction of 10 per cent. on the outlay.

76. Were those all the plans tendered before the Board of Works up to the 1st January 1862?—Yes.

77. Did you state just now that Mr. Bazalgette was not consulted on all the tenders and plans before you reported upon them?—Yes.

78. Then did you report without taking Mr. Bazalgette's advice?—Probably, I might have asked the question in Committee.

79. Was he always present when you discussed the plans in Committee?—Mostly, I believe.

80. Then you would be guided by his opinion, would you not?—As to engineering points we should.

81. As to what parts of the question would you not be guided by Mr. Bazalgette's opinion?—As to the question of finance, upon which we were quite as capable of judging as an engineer.

82. Upon all other questions he would give you his advice, would he not?—Yes.

83. Though he did not report in print, he reported to you upon the other plans, did he not?—I do not remember his reporting upon any except Messrs. Napier and Hope's.

84. You did not instruct him to report upon any other?—I think not.

85. Why did you not refer any other plans to him except that?—I believe that was the only one presenting anything like a complete scheme for the utilisation of the sewage. The parties had made surveys and had prepared, I believe, to give notice to apply for a Bill.

86. Was that the reason why you did not refer any of the other plans to him?—I think that the reason, probably, was that the engineering details of the other schemes were so scanty.

87. In this report of the Main Drainage Committee, you state this: "Your Committee, in deliberating on the various propositions, have been mainly guided by the fact, that two very material points were necessary to be secured; the first, the absolute necessity for guarding the Board against the consequences which would arise, in the event of a nuisance being created by the application of a sewage; and the second, the desirability of adopting, if possible, a scheme which should hold out a prospect of some benefit, in a financial point of view, ultimately accruing to the ratepayers of the Metropolis." Do you concur in the view, that those two points are necessary requisites for every scheme?—Certainly.

88. The Committee continue in those words, "These objects are, in the opinion of your Committee, more likely to be effectually attained by the scheme propounded by the Honourable William Napier and Mr. Hope than by either of the others which have been submitted to your Honourable Board." Do you agree with that part of the report of your Committee?—At that time I did.

89. Do you not now?—We have had fresh tenders sent in since then.

90. Take the first requisite, and confining yourself to that period before January 1st 1862, what were the reasons of a sanitary nature which induced the Committee to give preference to this scheme of Messrs. Napier and Hope?—Because of its removal from the Metropolis to a district free from human habitation.

91. They all propose to remove the sewage from the Metropolis did they not?—Not the Metropolis as understood by us within our area which is 117 square miles.

92. The others did not propose to take it beyond that area, did they not?—Some, I believe, intended to use it within that area, but I am not quite clear as to that.

93. For instance, Mr. Ellis intended to use it over 522,104 acres, did he not?—Yes.

94. Would not that extend beyond your area?—Undoubtedly a large portion of it would.

95. But then why do you on that ground give the preference to Mr. Napier's scheme over that?—At that time the proposition of Mr. Ellis was to pump the sewage on to Hampstead Heath on one side, and on to Shooter's Hill on the other, and having regard to the section in the two acts to which I have made reference, and they fear that some nuisance might result, that paragraph was inserted.

96. Without entering into Mr. Ellis's scheme, will you state why Mr. Napier's scheme was so far preferable to the others?—It appeared to us to be a more business-like scheme at that time. It was more complete in its general arrangements, the plans were drawn and the sections were given, and he expressed the intention to apply to Parliament for power to carry it out.

97. (To Mr. *Bazalgette*.) What is the total amount in tons of the sewage of the northern side of the Metropolis?—The sewage on the north side is altogether 87,000,000 gallons per diem.

98. How much would that be in a year?—It is probably worked out pretty correct in page 106 of this report of the Main Drainage Committee, where it is stated the annual volume of the sewage on the north side amounts to 36,967,285,300 of gallons.

99. How many tons would that be in the year?—168,033,115 tons.

100. (To Mr. *Thwaites*.) This they proposed to put upon 20,000 acres, did they not?—Not entirely; they proposed to reclaim 20,000 acres, and to apply the sewage to it.

101. Where do they propose to put that sewage of the northern side, which amounts to 168,033,115 tons?—I understood that they proposed

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posed to tap their tunnel at various convenient points, and to distribute right and left on their way to Maplin Sands.

102. Then they would distribute some in the Metropolitan area, would they not?—They might or might not.

103. Sir *Joseph Paxton.*] Could they do so.—They could have done so.

104. *Chairman.*] The greater part of those 168,033,115 tons of sewage would be discharged on the 20,000 acres of sands, would they not?—I believe they did intend to discharge there.

105. Supposing that it was all discharged there, how much would that be per acre?—I do not know without working it out.

106. Would it not be nearly 8,500 tons per acre?—I do not apprehend that they even intended to discharge the whole of that quantity on the 20,000 acres.

107. If they did you would allow, would you not, that it would be nearly seven feet deep, if it were all collected there at once?—No doubt.

108. Would not that create a great nuisance?—I think it would, supposing there were any parties likely to be affected by it.

109. Then if they proposed to do that, the first requisite of the sanitary state of the inhabitants would not be secured, would it?—There are no inhabitants there now.

110. How often do they propose to put it on in a year?—They could not put it on at one moment.

111. How often do they propose to put it on?—I do not remember the quantity that they propose to apply to those 20,000 acres.

112. Mr. Bazalgette, in his report to your Committee, states this: "The tract selected appears to be well adapted to the reception of the sewage, and is indeed the only one yet suggested to the Board, where, from its position, extent, and the nature of its soil, there would be a reasonable prospect of its receiving advantageously so large and constant a discharge of sewage, without creating a nuisance to the surrounding district." Do you agree with that opinion?—Yes, I agree with that, undoubtedly; I approved of the report of Mr. Bazalgette.

113. (To Mr. *Bazalgette.*) Do you wish to make any statement with regard to that?—You will observe that seven feet deep for the whole year would be equal to about a quarter of an inch in depth per diem. Now, a quarter of an inch in depth, a very large proportion being water which would be drained off, would leave a very small proportion of solid residuum; and it would take a considerable number of years with that quantity passing over the land to render it fertile. In a case of that kind, with proper drainage, it would not be excessive at all, it would take the whole of that quantity.

114. Lord *Fermoy.*] Have you read the report of the Royal Commission upon sewage, and you are aware that as much as 8,000 tons per acre has been applied with advantage over successive portions of the year?—Yes, I think that may be so.

115. *Chairman.*] Do you remember that in the report of the General Board of Health of 1852 they state that too much sewage should not be used at a time; that as much as 1,000 tons over an acre would be destructive of health, and would be baneful to the land?—I do not remember that remark, but I am quite sure that the application should be very much in proportion to the nature of the ground, and the quantity of drainage.

116. On sandy land, could not more be used than on clay land?—Yes, it would absorb very much more.

117. And it would be drained away, would it not?—It would filter through, and the water would be drained away, leaving the fertilising matter on the land.

118. Is it the case that on the Craigentinny meadows near Edinburgh, which are sand, where they do not put 8,000 tons, the sewage itself runs away in the sea?—I am not aware of that.

119. How is this land to be reclaimed?—By forming an embankment constructed out nearly to low water, and then forming dykes for the water to run into, so that it might discharge at low water into the sea.

120. Pass on now to the second requisite. You state, do you not, in your report, that you were supplied with detailed drawings and estimates of the proposed scheme, and that you found that the works had been carefully considered and well designed; is that the case?—That is so.

121. Can you state to the Committee what is the nature of the soil to be reclaimed?—A portion of it is alluvial mud over the sand, and another large portion is sand.

122. Are they quicksands?—Portions are of the nature of quicksands.

123. Was any provision made against the wall sinking in as fast as it was built, and being swallowed up in those quicksands?—Yes, sufficient provision was made to allow a large body of the bank to go down and form a solid foundation.

124. Were provisions made to allow the wall to descend to a solid foundation?—The bank would have been built and protected with fascines, and the heavy deposit would have settled down to a solid foundation.

125. Before you made your report, had any borings been made into the sand, so that you might know how far down this solid foundation would be?—Yes, they have.

126. Mr. Hopkins, in his report, states that from the boring of 14 or 15 Artesian wells, in Foulness Island, he finds that the sands were 40 feet deep, and he thinks that these Maplin sands are equally deep; do you agree with him in that opinion?—I do not agree with that, because my recollection is that there is not so great a depth, and that there will be a solid foundation within a reasonable depth, though I am not prepared to state what that depth would be.

127. Do you know how much less it would be than 40 feet?—I should imagine very much less.

128. You do not know that, do you?—I do not recollect what the depth was, and therefore I cannot speak to it.

129. Are you aware that Mr. Hopkins was very positive that an embankment could not be made on those sands?—I do not remember the opinion that Mr. Hopkins has expressed about it at this moment.

130. In number 74 of the publications of the Metropolitan Board of Works, at page 12, Mr. Hopkins's opinion is given in these words: "In considering the proposed scheme, we have first to consider the practicability of constructing a wall, capable of sustaining from 20 to 25 feet of water, on a quicksand, 40 feet deep, situated three or four miles out in the sea, and exposed to the heavy roll of the German Ocean; this wall, if it be possible to make it, will have to be, at the least, 30 feet in height; whether the promoters contemplate carrying their embankment through

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the 40 feet of sand down to the clay, I know not, but it is certain that any attempt to build it on the sands would be a failure, as the materials would (as in the case of stranded ships) sink into the sands as fast as they were placed there;" do you think that Mr. Hopkins is correct in that decided opinion?—No, I do not. I have had a great deal of experience in building sea walls, and there is not the least doubt in the world they could be done there with great safety. I know that sea walls have been constructed on the Essex coast in that neighbourhood.

131. Will you state that those quicksands are less than 20 feet deep?—I have not the information at hand, and I am not prepared to say what they are, but I did look into the subject at the time that it was before me with some care.

132. What depth is the sea over those sands near the place where they propose to build this embankment wall?—I cannot speak as to that at this moment.

133. Mr. Hopkins says it is 40 feet deep; is that so?—I am not prepared with the figures.

134. (To Mr. *Thwaites.*) Can you state to the Committee the depth of sea over those sands near the place where the wall is proposed to be built?—I understood that the retaining wall was to be built within low-water mark.

135. Was that the case with regard to the embankment?—I understood clearly that it was to be built within low-water mark.

136. Did you not state that it was to be reclaimed from the sea, and that it was now under water?—It is, of course, under water.

137. (To Mr. *Bazalgette.*) How is the land of Foulness Island situated as to level?—A large portion of the land is about the level of half-tide.

138. How far out at sea do they propose to build this embankment wall?—I am afraid I cannot speak to figures at all.

139. Is Mr. Hopkins correct in saying that it would be three or four miles out?—It is possible; those sands extend a long distance out, but I cannot speak to figures.

140. You knew that you were to be examined as to these tenders, did you not?—I did not know that it was intended to go into the details of any of those schemes.

141. What are the dimensions of this embankment wall?—I cannot give that.

142. (To Mr. *Thwaites.*) Can you give the Committee that information?—No, I cannot; but the engineers of the scheme will give the Committee all those details.

143. (To Mr. *Bazalgette.*) Do you think that such an embankment could be constructed on such a foundation as this sand?—Yes, I do.

144. Would it stand the force of the sea?—I think it would.

145. What was the cost of that embankment according to the estimate?—The total estimate is 2,000,000 *l.*; but I cannot state what proportion of that is due to the embankment and what is due to the sewer.

146. Mr. Ellis, one of those who made a tender, states that this embankment would contain 1600 cubic yards of earth for every lineal yard forward, and that it would cost several hundred thousand pounds, so that the whole would cost 18,000,000 *l.*; would that be correct? No; I should think not.

147. Was the attention of the Main Drainage Committee directed to the probable cost of this sea embankment before they reported in its favour?—It was; it was very fully discussed, I think.

148. And did they think that, in spite of the expense of this embankment, it would be beneficial in a financial point of view to the ratepayers?—I do not know that they went so far as that.

149. You do not think that it would have been beneficial to the ratepayers in a financial point of view?—I cannot give an opinion upon that point.

150. (To Mr. *Thwaites.*) Do you think that it would have been beneficial in a financial point of view?—Representations were made to us, which were confirmed by the engineer of the Board, that a retaining wall could be built without difficulty, by which 20,000 acres would be reclaimed, and that the sewage could be applied to that 20,000 acres, without any risk of nuisance being committed, or any person injured by its application; that, in order to convey the sewage to that point, they would require to construct a tunnel of something like 44 miles in length, and that right and left of that tunnel, passing through an agricultural district, they proposed to distribute the sewage as they could obtain customers for the article that they had to dispose of. Having regard to their power to distribute along the tunnel, and to the application of the sewage on the 20,000 acres to be reclaimed, and having regard to the fact, that it was the opinion of the Committee that these works could be carried out without committing a nuisance, we certainly thought that they did offer, on the whole, better prospects of freedom from nuisance, and of profit to the ratepayers, than any other proposition which was before us at that time.

151. Did you think that it offered a profit to the ratepayers?—Yes.

152. Will you state to the Committee your notion of the expense of building that wall?—I could not venture to offer an opinion upon that point, knowing that the parties must go before Parliament, and satisfy a Committee of this House as to the general scheme.

153. Mr. Bazalgette has just stated what he thought the embankment would cost, but refused to give it as his opinion that the ratepayers would be recouped; and you state that the ratepayers would be recouped, but refuse to give your opinion as to what it would cost; on what grounds have you arrived at that conclusion?—On the grounds which I have named; the reports of the parties, the plans and sections which were made, and the report of our own engineer. And having regard to the distribution of the sewage, I and my colleagues did arrive at the conclusion that some remuneration and benefit would arise to the ratepayers from the adoption of this scheme.

154. Did you found your opinion upon the report of Mr. Bazalgette?—As regards the structional cost of the works, we did.

155. You had to take into consideration the cost of the embankment, had you not?—No doubt.

156. Then your opinion was founded upon Mr. Bazalgette's advice, was it not?—On the engineering question, undoubtedly it was.

157. But none of the other tenders were submitted to him, were they?—No; for the special reason that no other scheme was in so perfect a form as to be submitted to him.

158. There is a statement made in a pamphlet which I have before me, that an admission was elicited from Mr. Bazalgette, before the Metropolitan Board, namely, that Mr. Bazalgette had

reported in favour of the scheme without any personal examination of the ground, he not having seen it for some 13 or 14 years; is that the case?—I am unable to answer the question.

159. You are the Chairman of the Board, are you not?—I am.

160. Was that opinion elicited before you and before the Board?—I do not remember.

161. To Mr. *Bazalgette*.] Was that the case?—Yes; I think the question was put to me whether I had visited the Maplin sands for the purpose of this scheme. I stated that I had not, but that I was acquainted with those sands, having seen them before, and that I had obtained the necessary information.

162. How long was it since you had seen those sands?—I think something like 10 or 12 years.

163. From whom did you get your information then?—From the engineer of the Company.

164. Do you mean the engineer of the proposed scheme?—Yes; the engineer of the scheme, Mr. Hemans, who is an engineer of very high reputation.

165. Did you get any information from the engineers for the other tenders?—I should have done so, if I had been called upon to investigate and report upon their schemes.

166. Do you consider that the promoters of the scheme are the best persons to give you an opinion upon that scheme?—I did not regard Mr. Hemans as a promoter of the scheme, but as a professional engineer.

167. But he was engaged by the promoters, was he not?—Yes, and if I had not consulted him it would have involved the Board making surveys, and going to a very large expenditure, which I was not authorised to incur.

168. Then would you be equally ready to take the opinion of the other promoters upon their schemes?—I should be equally ready to take a statement of facts from any engineer of high standing and position acting for any of these companies.

169. Then if another engineer, Mr. Hopkins, gave an opinion to your Board quite contrary to that which Mr. Hemans gave, would you still trust to Mr. Hemans in preference to Mr. Hopkins?—I do not know Mr. Hopkins as an engineer. I never heard of him until I heard of him in connection with this scheme. I do not know that he is recognised as an engineer.

170. You would take Mr. Hemans' opinion, although it is contradicted by Mr. Hopkins, Mr. Hemans being engaged by the promoters of the scheme?—Yes, I should.

171. (To Mr. *Thwaites*). Now we will proceed to the year 1863. In the early part of that year also, you stated that you advertised for tenders. When were those tenders opened?—The advertisement was on the 6th of March 1863, returnable on the 8th of May, and, subsequently, the period was extended to the 8th of July 1863.

172. Were they opened on the 8th of July 1863?—On the 8th or 9th of July.

173. In the advertisement, do you state that no tenders would be opened after the 10th of July?—Very probably it was so.

174. Are the tenders which were delivered to you before that date to be found in this Report of yours, dated 20th July 1863?—Yes, I hand in a report which contains all the tenders. (*The same was delivered in.*—See *Appendix.*)

175. Would you tell me the names of the gentlemen that tendered?—Doctor Thudichum, Mr. David Curwood, Lord Torrington, Sir Charles Fox, and Mr. Hunt, jointly; Mr. John James Moore, Mr. George Townsend, Mr. George Shepherd, Mr. C. F. Kirkman, Mr. Thomas Ellis, and Messrs. Napier and Hope.

176. What is the plan proposed by Dr. Thudichum?—There was some peculiar mechanical arrangement for separating the house drainage, so as to retain the valuable parts of the urine and of the fæces.

177. Does he retain the solid parts, and let all the liquid parts run into the river?—He retains the urine, and he proposes to apply it for agricultural purposes, and also for the production of certain dyes which will be found referred to in his tender.

178. Did he furnish you with details of the cost?—With nothing beyond what is contained in his tender.

179. (To Mr. *Bazalgette.*) Can you give any further detail as to Dr. Thudichum's process?—Its peculiarity is, that he proposes a closet-pan, which will separate the urine from all the refuse; and he proposes to have a separate system of drains to every house, or a number of these pans to every house, and a separate drain to carry the urine through the sewer down to Barking, there to manipulate it; and the whole of his return is based on the products of the urine. He estimates the cost of his works for carrying out his process at 1,500,000 *l.* There are about 300,000 houses in London, or probably nearly 400,000, and to lay down a new drain to each of those houses, some of them having more than one water-closet, could not be estimated, on the average, at less than 20 *l.* a house; that would be 6,000,000 *l.*, and that would not cover the pipage passing down to Barking, so that his estimate must be quite out of the question. Then I conceive his plan to be impracticable for this reason, I think that it could not be borne that every house in London should be pulled to pieces to substitute new arrangements; and by his scheme a large portion of the urine would still be wasted.

180. Then do you consider that scheme impracticable?—I do not think that it is practicable. I should be sorry to say that it is not worthy of further inquiry by the Committee, because, of course, Dr. Thudichum would put a very different interpretation upon it, and would think my views very erroneous indeed.

181. (To Mr. *Thwaites.*) What is your opinion as to that?—It is so complicated a matter, that I am unable to offer an opinion upon it; but it is as well worthy of the consideration of this Committee as of the Metropolitan Board of Works.

182. What is Mr. Curwood's plan?—It merely offers a suggestion, it is not a tender.

183. He forwarded no plan, did he?—No; he forwarded no plan.

184. (To Mr. *Bazalgette.*) What is Lord Torrington's plan?—Lord Torrington, Sir Charles Fox, and Mr. Hunt have never stated accurately what their views are. No plan has ever been sent in. We know generally that they propose to irrigate some lands with the sewage, but where, or in what manner that is to be done, has not been stated.

185. (To Mr. *Thwaites.*) Do you wish to make any remark with regard to that?—They state the very common difficulty that many of the promoters feel, namely, that it is undesirable to reveal the particular area over which they propose to distribute sewage, because it may interfere with the

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the arrangements that they may subsequently make with the parties.

186. What was the area stated in their first tender as sufficient for the whole of the sewage of London?—From 30,000 to 40,000 acres.

187. Do you consider that on an area of some 30,000 to 40,000 acres, they would recover a sufficient amount of extra crop to pay for that sewage?—I am not prepared to offer any opinion as to the value of the sewage.

188. (To Mr. *Bazalgette.*) Do they propose to utilise the sewage on lands in their own occupation, or to let it out to farmers?—It appears that they speak of the purchase of the land.

189. Did they intend to purchase the land?—Yes.

190. Did they inform you where those lands were situated?—No they did not.

191. What rent did they propose to pay to the Metropolitan Board of Works?—Their proposition was to pay the Board a certain per-centage on their profits after deducting interest on capital and working expenses. But another proposition is to levy a rent, or royalty to be determined by an arbitrator appointed by the Board of Trade.

192. (To Mr. *Thwaites.*) Did Mr. John James Moore furnish you with details of any plan?—I think not.

193. What was the area with which he proposed to deal?—Mr. Moore's area was 20,000 acres.

194. Did Mr. George Townsend, on the part of the London Sewage Utilisation Company, furnish you with any information besides what he gave you in his first tender?—I think not.

195. Did Mr. George Shepherd give you any information as to the extent of the area on which he proposed to utilise the sewage?—10,000 acres.

196. Did he give you any details of his plans?—I think not.

197. Did he furnish you with any details as to the cost of his works and the annual expenses?—I do not think that he gave any amount for works.

198. Did Mr. Thomas Ellis, in his last tender, make any alteration in the plan of distribution, and of the utilisation of the sewage which he laid before the Board of Works in the first tender?—I think not.

199. Did he make no alteration in his plan?—I think not.

200. Did he, in his second tender, ask for any interest on the capital which he would expend?—I am not aware at this moment that he did.

201. Did Messrs. Napier and Hope make any alteration in their second tender?—I am not aware, without comparing the two, whether any alteration was made. Their proposal was, after deducting the 10 per cent. upon the outlay, to divide the profits equally between the Company and the Board.

202. At page 3 of the Report of the Main Drainage Committee, No. 121, you state that nine communications were received, and that none of them fully complied with the terms of the advertisement, and that three do not make any proposals of the nature of a tender; is that so?—That is so.

203. After enumerating the first six, you state that there remain three communications purporting to be tenders in answer to the Board's advertisement, namely, Mr. Kirkman's, Mr. Ellis's, and Messrs. Napier and Hope's. In what do the terms contained in these communications differ from those contained in the other propositions, so as to disentitle them to be considered as tenders?—Mr. Kirkman's has always been considered as a tender, undoubtedly.

204. You say that there were three communications, purporting to be tenders, in answer to the Board's advertisement. How do you consider those three to be tenders and not the others?—None of the tenders complied with the terms of the advertisement.

205. Did not even those three comply with the terms?—None of them fully complied with the terms of the advertisement.

206. But why do you consider those more in the light of tenders than the others?—From the nature of the propositions. It is very difficult in some cases to determine whether they are tenders or mere suggestions.

207. The 9th of July was the last day, was it not, on which you said that you would open tenders?—I believe that is so in the advertisement.

208. In September and October, certain communications with regard to the utilisation of the sewage, were addressed to your Board, which have been printed, is that so?—I believe that is so.

209. Was one of them from Mr. Nelson?—I believe so.

210. What is your opinion of that gentleman's proposition?—I do not remember it at this moment; the Board published all the propositions that were made, and the whole of the information that was given, and it is a very voluminous matter.

211. The next communication is signed by Mr. Darling Westwood and Mr. George White, and they state that it appears that the sewage should be utilised at the rate of 350 or 400 tons to the acre, and that the farmers could well afford to pay 2 *d.* a ton for it; what is your opinion as to that?—I am unable to answer that question; that is not a tender.

212. The next communication is signed by Lord Torrington and Sir Charles Fox, and is dated October 26, 1863. They state that in pursuance of the letter of the 1st of August, they have given careful consideration to the question of the utilisation of the London sewage. If you turn to that letter, you will find that they merely state that should time be granted, they would undertake to submit the scheme on or before the 26th of October 1863?—Yes.

213. Does this refer to their plan of putting the sewage of the metropolis over 30,000 or 40,000 acres?—I suppose it does.

214. In their letter of the 26th October, they go on to state that, having considered the matter in all its aspects, they are determined to put the sewage on some 250,000 acres, is that so?—That is so.

215. What fresh information as to the proper extent of the area over which the sewage should be placed had been laid before the public between the 6th of July (the date of their tender) and the 26th of October, so as to justify their change of plan?—It is within their own breasts; I do not know any of their reasons for the alteration.

216. Was there any other information laid before the public between these dates?—Not by us; not as to the necessary area for the distribution of the London sewage.

217. The tenders had been all printed, had they not?—They were all printed.

218. They were distributed, and the public had the

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the means, had they not, of knowing what the other tenders were?—No doubt.

219. The next communication was from Mr. Charles Johnson. Do you know what he proposed?—I do not.

220. Did he propose to dry the mud, and convert it into a powder, and so utilise it in that way?—I do not remember that.

221. What would be your opinion of that, if that was the proposal contained in the tender?—I do not think that it would answer.

222. Is not the sewage of greater value as contained in a liquid form?—I think that the application of the sewage in a liquid form is the best.

223. Are you aware that Messrs. Hofmann and Witt have stated that the liquid contains six-sevenths of the sewage in solution, and that there is only one-seventh in the mud?—I believe that that is so.

224. Therefore that plan would not succeed would it?—I think not.

225. What is the amount of the sewage on both sides of London?—I think that the daily discharge is something like 431,217,000 gallons.

226. What would that be in the year together with the rain-fall?—That is the dry weather discharge. I do not know what it would be with the rain-fall.

227. Would it be 217,762,650 tons?—Probably it would be so.

228. Do you think that the farmers are aware of the value of the sewage?—Probably some farmers are aware of it.

229. Do you think that the interests of the ratepayers would be best secured by having a fixed rental or a fluctuating rental for the sewage?—A fixed rental, if that rental is equal to our views of its value.

230. But suppose a company were formed, and that but very few farmers would utilise the sewage, the Company would not be prepared, would they, to give you such a rental as they would in a few years, when the thing had become generally known?—When you speak of a fixed rental, of course a bird in the hand is worth two in the bush, and rather than divide a profit, whatever that profit may be, as compared with a fixed rental, one would prefer a fixed rental.

231. Even though you would get less from any company now than you would 10 years hence?—That may or may not be so; it may produce more, or it may produce less.

232. Is it your opinion then that a fixed rental would be the best?—I should prefer a fixed rental myself.

233. And you would debar the ratepayers from ever getting any more advantage than they would get from a fixed rental which would be offered at the present time?—That depends on the quantity of the sewage to be dealt with; that is, taking the present sewage; the prospective sewage is another question.

234. The question which I put to you was this: If the sewage of all London were to be utilised, would you rather have a fixed rental or a fluctuating rental; that is to say, would you rather have the price which would be paid at the present time, or that which would be paid in a few years when people would have learnt the value of the sewage?—It must be subject, of course, to the prospective increase of the sewage.

235. But supposing that there were no increased amount of sewage, will not farmers, in a few years, have a very different view of the value of sewage from what they have now?—It is a balance of probabilities.

236. They would employ more in a few years, would they not, than they would employ at the present moment?—No doubt, if it should prove successful.

237. If it should prove successful, would not a greater price be obtained for it in a few years than would be obtained now?—That would be so.

238. Then, in that case, the ratepayers would be able to obtain a great deal more in a few years than they would now, would they not?—Yes.

239. Then you would not prefer to have a fixed rental now, would you?—I have no very fixed idea on the subject; but my own idea is to secure the rental as speedily as possible.

240. Lord *Fermoy*.] You stated just now, in answer to a question put by the noble Chairman, that you would prefer a fixed rental to a participation in the profits; by a fixed rental you do not mean a rental fixed at one sum all through, do you?—No.

241. You would mean by a fixed rental, I perceive, a rental which would be progressive, and a rental which would be in proportion to the extended operations of the Company?—That was the purport of my answer.

242. Can you inform the Committee in what state all these projects are which are before the Board of Works at present?—The Board are now considering the subject.

243. Then all the parties in fact are still in court, that is to say, they are still competing before the Board, is that so?—Yes.

244. Can you give the Committee any idea of the time at which the Board of Works will have come to a decision on the subject?—I am unable to say at this moment, but I think that at all events the Board will, in deference to this Committee, postpone their decision until the Committee have reported; they will be glad to take advantage of any fresh information which they can get upon the subject.

245. With regard to the different areas which these Companies propose to deal with, have they put the Board of Works in possession of the details or the grounds upon which they have estimated these areas?—They have not calculated the area at all in many cases.

246. It is very easy for a man to say I can allocate 200,000 acres, but they have not put you in possession of the details, have they?—They have not.

247. Then, in point of fact, you have not got the proper means of forming a just estimate as to which is the best project?—We have no doubt a good deal of information before us which is mainly contained in the book which I have handed in to the Committee. The Board, of course, would be glad to know the particular area, and the extent over which these parties propose to operate; but for the reasons given by several of the parties they decline to reveal that area at the present moment on the ground that it would be prejudicial to their scheme.

248. In fact they have declined to supply you with the evidence, have they not?—Yes, some of them have.

249. In that event have you taken an opportunity yourselves, by means of your engineer, of ascertaining generally the amount of area which would be capable of receiving the sewage of London?—We have not; of course, we have our own individual opinions as to the application of the sewage, but the several propositions contain

various

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various notions as to the extent which is required. Some propose to place on the land a very much larger quantity than others, and we are open to the propositions of any parties that may be disposed to take the sewage, and we wish to consider what is best for the interest of the ratepayers.

250. But you have not thought it necessary to call upon your own engineer to give you a special report upon the subject?—It is an agricultural question, and scarcely an engineering question. It is a question that must be determined by experience.

251. But you will admit that you must ascertain first the possibility of allowing the sewage to go by gravitation; that is their proposition. You must see where the area is to which it can possibly go, and after that you have to see whether it can go there at a profit; is not that so?—My suggestion to several of the parties has been, "Why do not you try the sewage of a town of sufficient elevation to enable you to discharge it by gravitation, and so give us some practical illustration that would guide us, because in dealing with the large mass of the sewage of the Metropolis, that sewage having to be lifted and distributed at various points, it is a very large and difficult question.

252. Then, in fact, you are in the dark upon the details as to the profitableness, or indeed as to the possibility of carrying out these schemes with profit to the shareholders?—We believe that the sewage is valuable, and that if it can be conveyed to the land at a reasonable rate it will produce a result which, we hope, will be a profit to the ratepayers; but we are undoubtedly without any information as to the actual value, because the plan has not been sufficiently tested over a large area to enable us to form a correct judgment as to that point.

253. You stated just now, did you not, that you looked forward to the increase of the sewage of the Metropolis being very great?—No doubt; as the population increases very rapidly.

254. Do you found that opinion solely upon the increase of population?—Yes.

255. Mr. *Tite.*] What is the date of that book which you have put in, and which the noble Chairman has?—July.

256. Are you aware of a meeting that was held at the Metropolitan Board, when you were unavoidably absent by the death of your father?—I remember such a meeting having taken place.

257. Of course you saw the Minutes of what occurred at that meeting; and, if necessary, you can put them in, can you not?—Yes; I propose to put in all the Minutes, if the Committee require it.

258. After the discussion with Sir Charles Fox, was he not required, with Lord Torrington, to submit to the Board a distinct proposition of what he would give for the sewage, having the annual quantities which he had obtained from the statements, as he at present proposed to use the sewage?—I think that was so.

259. And have you had any result from that promise?—I believe that there is a letter which I can put in, but I am not quite sure.

260. Supposing that the Board adopted that principle of having a fixed rental for the sewage, the lessee taking it and doing what he pleased with it, there would be no difficulty in applying the additional principle that if it became proportionably valuable that rental should be increased; but all that you referred to was any experiment that might be made as to lifting or carrying the sewage anywhere?—What I mean was, not that you should have 50,000 *l.* for the next 50 years, for instance, but that you should have a present fixed rent sufficiently elastic to apply to the improved value of the sewage and to the increased amount of the sewage.

261. (To Mr. *Bazalgette.*) At any point where the sewage could be conveniently collected together without offence to the neighbourhood, is it high enough to irrigate the land without pumping it up?—Yes, a large tract of it is on the north side of the river, passing through the marshes down to Barking, and some distance beyond Barking, between Plaistow and Barking; the sewer itself is considerably above the land, and, therefore, by laying pipes along the land it might be very easily irrigated.

262. At Barking itself is it too low for such purposes?—No; it might irrigate there by gravitation.

263. Over what extent of land would it irrigate by gravitation?—Over some thousands of acres, but I cannot state the exact quantity.

264. To Mr. *Thwaites.*] When you speak of that report being published, you simply mean that it is published for the benefit of the public, and that the world generally may become acquainted with its contents?—That is so. The tenders were published in that book which I have handed in.

265. Were they sent to each member of the Board?—Yes.

266. With regard to this important report which contains the tenders, you believe, do you not, that it was sent to every member of the district Boards and vestries for their information?—I believe that a copy was sent to each of the persons who sent in tenders.

267. But were they sold?—The vestries are very numerous, and people are sometimes in the habit of applying to printers for copies, and then they pay the cost price.

268. Sir *Joseph Paxton.*] Are you not aware that they were advertised?—Not by the Board.

269. But were they not advertised?—I never heard of it. There is no secret at all in the matter. The Board felt that this was a matter so important that, as trustees on behalf of the general Metropolitan public, they were desirous of publishing all the information which was laid before them.

270. Mr. *Hibbert.*] You stated that Mr. Bazalgette was not consulted on all the plans. Why was he not consulted on all the plans?—Because I think that with one exception the Board received no plans; it was a mere general statement from the parties that they proposed to apply the sewage to 200,000 or to 300,000 acres, without any plans or sections whatever being submitted to us.

271. Then were Messrs. Napier and Hope the only parties who deposited plans with you?—Yes.

272. Did they deposit any plans of the land on the right and left of the culvert, to show what ground they proposed to irrigate before they got to the Barking lands?—I think that they complied with the standing orders wherever they proposed to carry their works.

273. Did I rightly understand you to state that you considered that the mode in which Mr. Ellis intended to irrigate the agricultural lands might be a nuisance within the Metropolitan district?—I did not state that Mr. Ellis's plan would be a nuisance;

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nuisance; I simply stated, in answer to a question put to me by the Noble Chairman, that Mr. Ellis proposed to pump the sewage to Hampstead Heath to the north, and to Shooter's Hill to the south; and the Board having regard to the sections of the two Acts to which I have made reference, felt, of course, a natural anxiety that we should carefully examine any plan that might be submitted to us and satisfy our minds that no nuisance would result from such an application of the sewage.

274. Did you not refer to the mode of distribution of the sewage after it had left the reservoirs? — Of course the Board considered the question, whether its application in quantities would produce a nuisance.

275. (To Mr. *Bazalgette.*) Do you know of what material that embankment was proposed to be formed?—That embankment was proposed to be formed of clay, and faced with fascines.

276. Where would the clay be obtained from? —I forget where it was to be obtained from, but somewhere on the coast.

277. Was it from any place near?—Not very near; it would require to be barged.

278. Would not the embankment require to be pitched with stones?—It required to be faced with fascines or stones.

279. Do you think that that would be sufficient to withstand the sea?—Yes; if it had sufficient slope.

280. Are they not subject to storms on that coast?—Yes. The probability is, that that bank would form a natural face; the sands would warp up the face of that bank, and form a shelving beach of itself in course of time.

281. That would be rather an expensive embankment altogether, would it not?—No; it would be rather a cheap embankment.

282. The clay would require to be brought a considerable distance, would it not?—It would be brought in large barges.

283. Sir *Joseph Paxton.*] Do you know any part where it would be brought from?—I did at the time, but I have not refreshed my memory upon it. I think it was proposed to use a great deal of chalk.

284. Mr. *Hibbert.*] Where would the chalk be obtained from?—I think from the mouth of the Thames.

285. At what distance is that?—There is a great deal of chalk below Erith.

286. Sir *Joseph Paxton.*) Do you think that chalk would be a likely thing to form an embankment there of a solid nature?—Of course the embankment will require to be puddled; but I think that a chalk embankment would be a likely thing. Mr. Hemans will give the Committee all the details upon that point, as he will have the documents before him.

287. Mr. *Caird.*] (To Mr. *Thwaites*). What definite plans are now before you?—When you speak of definite plans, I regret to say that none of them are very satisfactory to us.

288. But you stated, did you not, that you had at present some plans under consideration?—We have the whole of them.

289. How many of these plans now under consideration are of a definite character?—Six or seven of them, probably.

290. Has any new project been laid before you since the publication of that report of last year? —No.

291. Then there is no new project under your consideration other than those which have already been published in the report?—No.

292. You stated that you would prefer a fixed rental to a fluctuating one, provided that that fixed rental met with your views of its present value; would you state to the Committee your views of its present value?—I should prefer not to answer that question. For aught I know the Board may deem none of these propositions satisfactory, and they may re-advertise the whole question.

293. But have you arrived at some definite view of the value of the sewage in your own mind?—I had rather not answer the question. We are glad to get the most we can. What I wish the Committee to understand in reference to my answer was this, when I speak of a fixed rental, I mean a fixed rental to commence with. I always had regard to an elastic scale, that will apply to the increased value of the sewage, and the increased quantity of the sewage to be dealt with. I speak of a fixed rental as in contrast to a position that the Board should take from the parties one-half, or one-third, or three-quarters of the profit that they may ultimately secure.

294. Have you considered what quantity per acre, or over how many acres of the whole of the sewage of London might be profitably distributed? —I have not formed any opinion upon that point.

295. Is not that at the base of any computation either as to its value to you, or as to the particularity of any scheme that you may think it right to recommend?—Very able men differ very widely on that question, so that it would be very imprudent for me to decide it. It can only be ascertained by practical experiment, and it will very soon be proved.

296. Have you not at the Metropolitan Board of Works, arrived at any definite conclusion on that point?—No.

297. You stated that it was desirable that certain experiments and examples should be brought before you from certain small localities in order to guide you in London. Are you aware that such experiments exist?—Yes, to a certain extent, but I should be glad to see those experiments multiplied over a general mixed soil.

298. At this moment then, are the Committee to understand that the Metropolitan Board of Works have no definite idea in their own mind as to what it would be advisable for them to accept in the shape of a plan?—The Board of Works would be guided of course by the best plan which they could secure. They have taken the best means in their power by advertising, and they have spent about 183 *l.* in that way in advertising, and in inviting tenders from the general public, and all that the Board can do is to consider the results.

299. Without entering into the details of any of the plans before you, with regard to a question put to you as to Messrs. Napier and Hope's plan, are you aware whether the 20,000 acres, which they propose to embank in the sea was intended rather as a receptacle for the sewage which they could not use in the 44 miles of tunnel?—I believe that they did intend to discharge the sewage which was not used on that area.

300. On that extent of 44 miles, taking a square mile on each side of that tunnel, are you aware that a very large quantity of land would be found on each side which would require that sewage?—The view that the Committee took was that there was a very large area on which the sewage could be applied profitably.

301. Mr.

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301. Mr. *Bright.*] (To Mr. *Bazalgette.*) Did you not state just now that there was a portion of land to which sewage could be applied without much expense, inasmuch as it is considerably below the outfall?—Yes.

302. (To Mr. *Thwaites.*) Would it not be possible to make a considerable experiment there without any unreasonable expenditure, so that you might ascertain definitely what is the value of this sewage?—One can scarcely apply the sewage to those marshes in their present condition. Those marshes are intersected with cuttings which are filled with water, and any large addition to the rainfall must be carried off, and probably would involve a lift, in order to drain those marshes, and it would scarcely be a fair test of its application.

303. Taking into consideration the cost of distribution, are you able to state that the Board of which you are the chairman have a distinct opinion that the value of the sewage of London is great?—We believe that the sewage of London does possess a considerable value, but that is dependent, of course, on the mechanical arrangements for its distribution, and the result of its application generally to the land. Small experiments upon a particular soil are scarcely sufficient to enable us to know how we can apply 87,000,000 of gallons per diem on the surrounding land. You must, of necessity, require a large area, and that area must be of a mixed character. Its application to a sandy soil or to a clay soil may vary very much, but what I stated before, and what I repeat, is, that one would be glad if some further practical illustration of the application of sewage might be made in towns where it could be done without any mechanical lift, by mere gravitation. I believe that in Coventry they are now making arrangements with regard to the sewage, to the result of which we are looking forward with some interest.

304. Who is conducting those works at Coventry?—I think Mr. Shepherd.

305. Has the Board of Works had correspondence with other towns with regard to the question of sewage?—There the experiments are not yet tried; they are now making arrangements for doing it. I understood Mr. Shepherd to state that he had entered into some arrangements with the Corporation of Coventry for its sewage, which he proposed to apply to the surrounding land, but that the operation is not yet at work.

306. Do you know whether any experiment of the kind has been tried at Rugby?—Yes.

307. Is that under the same engineer, or under some other?—It is not under the same engineer, but I cannot give any details as to the result at Rugby.

308. Lord *Fermoy.*] (To Mr. *Bazalgette.*) With regard to the marshes, you stated, did you not, that at Barking several thousands of acres of land might be irrigated by gravitation?—I did.

309. Could you give the Committee an idea of the quality of that land; is it marsh land?—It is marsh land; it is rich pasture land, mostly.

310. Is it marsh that has been drained?—Yes, it is marsh that has been drained.

311. Is it above or below the level of high water?—It is below the level of high water.

312. Then do you think that it is possible to irrigate that land with advantage to a greater extent?—Yes, at certain seasons of the year, I am sure that it might be done.

313. Do you refer to the several thousands of acres of land that extend between London and Barking?—Between the River Lea and Barking; and the same thing would apply to the Erith and Woolwich marshes, on the south side of the river.

314. There, again, it would go by gravitation, would it not?—It would flow from the reservoir by gravitation over those lands, and they could be drained at low water; the water running off with the river.

315. Those marshes are intersected, are they not, by small canals?—Yes; they are intersected by canals or dykes.

316. They empty themselves at low water into the Thames, do they not?—Yes.

317. Do you think that it would be possible, at certain seasons, to irrigate the land between the canals with advantage?—I think that it would.

318. At present it is rich land, is it not?—It is very good land.

319. Have you any idea what it is worth an acre?—I should suppose that it is worth from 3 *l.* to 4 *l.* an acre.

320. Have you formed any idea as to what the rent would be if it were irrigated?—I have not; but I have no doubt that it would be very much improved.

321. But you do not think that it would be so much improved by irrigation as inferior land would be?—No.

322. How is that land held; is it generally held by lease?—I think it is.

323. Have you formed any idea as to whether the parties who hold that land would be disposed to take the sewage at a rent?—No; my impression is, that they would not be disposed to pay a rent for the sewage, but that they would not object to take it if it were given them, and to try the experiment.

324. You think that they would not object if they got it for nothing?—Not if they got it for nothing.

325. You stated that the sewage might be used on that land at certain seasons of the year; have you formed any idea during how much of the year you could dispose of the sewage there?—If it were grazed, I should suppose for four or five months in the year.

326. To which months do you refer?—To the summer months.

327. While the sewage is lying there, during those hot months in the summer, do you think that there would be any injurious effect to the health of the inhabitants of the neighbouring country?—I think that those marshes are mostly pretty remote from dwellings. But if it was overdone it might be injurious; and if that was found to be the case, it might be regulated at any time.

328. Do you suppose that there would be any danger in hot weather, with an easterly wind, of that injurious effect extending as far as London?—I think that that need not be so, if it is carefully done; but I think that if it were overdone, it might be injurious.

329. Are you not aware that there is, in the soil itself, commonly, a deodorising principle?—Yes.

330. Are you not aware that sewage put upon sand as irrigation, and sewage kept in a large reservoir, are two very different things, *quoad* the health of the neighbourhood?—Yes; but when irrigation is carried on to a large extent it becomes a nuisance.

331. But does it become a nuisance to the

same extent as if it were a reservoir?—No, not to the same extent, because the effluvium goes off more rapidly.

332. Sir *Joseph Paxton.*] Are you not aware that those marshes are so unhealthy that the people cannot live in them?—I believe that they are subject to ague there.

333. Are you not aware that during a very large portion of the year they are submerged?—No, I think not.

334. Did you ever travel by the Eastern Counties Railway down to Cambridge?—I have been going up and down that line, and over those marshes a good deal during the last four or five years, and I have never seen the marshes to which I now refer submerged.

335. You state, do you not, that if this irrigation were not overdone, it might answer the purpose to use the sewage there?—Yes.

336. What do you think would be overdoing it?—I am not prepared to say what amount of sewage it would take.

337. Have you formed no estimate in your own mind as regards what amount could be used there?—No, I have not.

338. You stated, did you not, that a large quantity would be used out of the culvert as it passed down, before it came to the Maplin Sands?—Yes.

339. Do you mean that it would be used over this land of which we are now speaking?—Yes, some of it probably over a portion of this land.

340. But you can form no opinion as to how much of the sewage would be used before you get to that land, is that so?—This would be the starting point of the culvert, and it would extend a couple of miles, perhaps, out of the 44 miles; and there would be other tracts of land which would be equally available for the irrigation.

341. (To Mr. *Thwaites.*) You state that, according to the advertisement for tenders, all the works would become forfeited to the Metropolitan Board of Works, in the event of failure?—In the event of their not completing the works, that was to be so, but that was all that was intended.

342. Do you not think that an advertisement of that kind, with such a penalty attached to it, would act injuriously, as against the formation of a company?—Probably to a certain extent it might.

343. Do you think that if a landed proprietor, who allowed a railway to pass through his land, had a clause in the Bill that all the works done on his lands should be forfeited if that railway was not carried on, that would be likely to prevent the carrying out of any railroad system at all?—No doubt that would be the case; but the cases are not analogous at all.

344. In what respect are they not analogous?—Because the Board would be parting with its control over the sewage to an incompetent body, supposing their incompetency to be proved by their non-completion of the works; and the hands of the Board would be tied, so that they would be unable to dispose of the sewage to another party, who might be competent to utilise it, and great inconvenience would result therefrom.

345. But would not the landed proprietor be parting with his land in the same way?—The landed proprietor would be parting with his land, no doubt, but there is no resemblance between his position and that of the Board; the Board would be parting with the whole of their land, to use the Honourable Members' simile, that is to say, with the whole of the sewage.

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346. Do you mean to say that the Board might not have the power of recovering the sewage?—A variety of conditions might be suggested, and probably some might be suggested which would be less objectionable than the one which is suggested in their advertisement.

347. Then do you consider that that is an objectionable proposition?—The Board were anxious to be secured against mere speculators.

348. Do you think that that proposition is objectionable?—If we had had no objection to receiving propositions from parties that might fail, we should have excluded that particular part of the advertisement. We know that parties would be glad to have possession of the sewage to hawk it about, and sell it to any person or company.

349. Do you know any case in which the sewage has been used over a small area?—It has been used at Edinburgh, it has been used at Rugby, and it has been partially used at Croydon.

350. Have you made yourself acquainted with the results which have lately been obtained at Croydon?—I have not.

351. Are you acquainted with the results at Rugby?—I am not, except from the reports; I have not personally visited Rugby.

352. Do not you think that it would have been as well that those experiments should have been inquired into by the Metropolitan Board of Works, so that the Board might have made themselves acquainted with the facts of the case?—I doubt very much whether a single visit to Rugby or to Edinburgh would have been sufficient.

353. Supposing that a dozen visits would have been necessary, still would not that have been time well spent?—No doubt, if that would have given the necessary information it would have been so. We have advertised to the world, and we are ready to receive tenders for this purpose.

354. Do not you think that if a man has an article to sell, he offers an opinion as to what his article is worth?—No doubt he does in the case of an ordinary article, but of this particular article the value is not so clear.

355. *Chairman.*] You are acquainted, are you not, with this report on the Metropolitan Main Drainage?—Yes.

356. Are you aware that Messrs. Hofmann and Witt have stated, and that those who made this report have corroborated them in that statement, that 1,250 tons of liquid sewage are equal in value to one ton of guano?—Yes.

357. Sir *Joseph Paxton.*] You stated that with regard to the intended distribution of the sewage of the Maplin Sand, it would be an absurdity to think of putting the whole of it there?—Speaking of the whole of the sewage of London, that would be clearly so.

358. Taking into consideration the fact that the marshes over which the sewage would pass on its way to the Maplin Sands would have to be irrigated with that sewage, how large a portion of the sewage could be used upon that land?—It is marsh land from the point at which they take the sewage to the point at which they discharge it. I mean to say that the land through which their tunnel passes is mainly ordinary agricultural land. I find that I have a communication from Lord Torrington and Sir Charles Fox, and one from Messrs. Napier and Hope, on this subject, and, if the Committee will allow me,

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me, I should like to be permitted to add it to my evidence. (*The same was delivered in.*)

359. (To Mr. *Bazalgette.*) You stated, did you not, that you had had some experience in making sea walls?—Yes.

360. In what part of the country have you had that experience?—In Lough Swilley and Lough Foyle, in the north of Ireland.

361. Was it on quicksands that you made the walls there?—Yes; part of the bank on Lough Foyle was sand.

362. Was it quicksand?—No; it was hardly quicksand, it was soft sand, but it was not such a quicksand as would swallow up vessels.

363. *Chairman.*] Is it not the fact, that a vessel could ground herself on that sand and be quite safe?—Yes.

364. Sir *Joseph Paxton.*] You stated, did you not, that you made a report upon Messrs. Napier and Hope's plan?—I did.

365. You also stated that you did not see this place for 10 or 12 years prior to making that report?—I stated so.

366. You knew, of course, that your Board would be guided by your report to a large extent?—I did.

367. Did you not think that it was necessary on your part, before you made that report, either to have visited that place, or to have made some experiments in order to enable yourself to form a correct opinion upon the matter?—No; I thought that it was sufficient to ground my opinion upon the surveys which had been made by Mr. Hemans.

368. He is the engineer of the Company, is he not?—Yes. It was never intended that in making a report I should go and survey the ground myself, but that I should form an opinion upon the facts that had been produced before the Board.

369. But was not your Board to be guided by your opinion?—Yes, clearly.

370. And your Board did form its opinion, did it not, upon your report?—Yes; I have no doubt that they did, on the engineering part of the report. In fact, I reported only upon the engineering character of the scheme.

371. You were asked a question with regard to Artesian wells, and you stated that you were not aware to what depth they went for water?—I do not remember the particulars now.

372. Then how did you come to the conclusion that walls such as you speak of could be built of chalk there?—Because I had at that time all the facts before me. I made every inquiry as to the mode of constructing the works, and as to the nature of the soil, and I formed my opinion upon those facts.

373. Supposing that I intended to enter into a company for a speculation of this kind, but that for safety's sake I employed you as an engineer to give me your opinion with regard to those sands, would you feel yourself justified in reporting in favour of that plan without making any inquiry?—If I had been called upon to report upon any special point of that kind, I should have inquired into it myself.

374. Were you not called upon to report for the guidance of your Board?—Yes, I was called upon to report on the soundness of the engineering features of the scheme. If it had been necessary for me to go and visit the sands myself, and ascertain the depth of them, it would have been equally necessary that I should have made all the other surveys, which I did not profess to do.

375. As the officer of a public Board you did not think that it was necessary to make proper inquiry, which you would have made if you had been employed by a private individual; was that so?—I did make a proper inquiry. An engineer of considerable eminence was employed to prepare those designs, and to obtain complete information. He did obtain that information, and he laid it before me, and satisfied me as to the practicability of the scheme.

376. *Chairman.*] Was that Mr. Hemans?—Yes.

377. (To Mr. *Thwaites.*) You stated, did you not, that small experiments would give no sufficient information, but that it would require a series of experiments over a large area?—No doubt small experiments to a certain extent do give information; but what I stated was this: that myself and my colleagues would be glad to see the operation of the sewage on a larger area, and its results on general mixed soils.

378. Do you know that in this report on Metropolitan Drainage 1857, it is stated that the sewage of London ought to be applied over an extent of 90 square miles, in order to be equal to the application of sewage over the Craigentinny meadows in Edinburgh; and that it is also stated that it would be too much, and would stink, and be unhealthy, and that if it were placed over a more extended area the offensiveness would be much less?—No doubt over a moderate area that would be so.

379. (To Mr. *Bazalgette.*) You stated, did you not, that the sewage would be placed on this land only during five months in the year?—No, I was simply giving my view as to the experiments on the marsh lands.

380. Then would you put the sewage over the land between the Abbey Mills and the Maplin Sands during the whole of the year?—I can hardly conceive that the sewage would be applicable to the land during the whole of the year.

381. What would you do with it at those times at which it was not applicable to the land?—I should take it into the present outfall.

382. Are you aware that it has been stated in Report on Metropolitan Drainage, that even if the sewage is taken into the Thames at the River Crouch, it would flow up, and that Mr. Lawes states, in the Report on the River Thames, 1858, that if it were discharged at Barking it would flow up to London?—I do not think that that is a correct view.

383. There are other streams which flow into the Thames, are there not, which are within the metropolitan area, and which are already polluted by sewage?—Yes, there are.

284. Then, it is the fact, is it not, that the Thames would not become pure merely by carrying this sewage away?—It would not.

385. In this report of the Board of Health, an engineer named Lee gives estimates for conveying and distributing the sewage, and he calculates the cost, including engines and all the necessary apparatus for working, at 1 *l.* 15 *s.* 5½ *d.* per acre; can you give the Committee any notion whether or not that is correct?—I could not give an off-hand opinion upon that subject.

386. Have you formed any opinion as to how much the necessary works would cost?—I think that it is impossible to estimate the cost of the works without having a proper survey of the land to be irrigated and the levels of the ground.

387. A

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387. A separate estimate would have to be made for each town, in fact, would it not?—Unquestionably.

388. Mr. *Caird.*] (To Mr. *Thwaites.*) Will you state what you consider to be the boundaries of the metropolis?—117 square miles is the area.

389. Could you name the limits within which those boundaries are contained, beginning on the north side of the river?—The following places will give a tolerably accurate idea of the boundaries: Hammersmith, Willesden, Kilburn, Hampstead, Highgate—Brentford is not within the limits—Old Ford, Bow, and the River Lea. These places form the boundary generally, on the north side. On the south side, Woolwich, Greenwich, Penge, Sydenham, Tooting, Clapham, and Putney.

390. Then, within those limits, are the Committee to understand that the Metropolitan Board of Works object to the use of any sewage for agricultural, horticultural, or other purposes?—The Board of Works have not objected in terms to the application of the sewage within their limits; but I think that they would look with great caution to any such application in so large and populous a district as the metropolitan district.

391. Then in examining the plans which are laid before you, you would give the preference, would you not, to those which would distribute the sewage outside those limits which you have referred to?—Certainly.

392. Mr. *Hibbert.*] Did Messrs. Napier and Hope give any survey, or have they shown the levels of the land between the Abbey Mills and the Sands?—They have.

393. From those plans can you state that they would be able to irrigate the adjoining lands?—Yes, the Parliamentary plans were deposited, and those I have had, together with the information prepared upon them.

Jovis, 12° *die Maii*, 1864.

MEMBERS PRESENT:

Mr. Sclater-Booth.
Dr. Brady.
Mr. Bright.
Mr. Caird.
Mr. Ferrand.
Lord Fermoy.
Mr. Hibbert.
Mr. Leader.
Lord Robert Montagu.
Mr. North.
Sir Joseph Paxton.
Sir William Russell.
Mr. Tite.

LORD ROBERT MONTAGU, IN THE CHAIR.

The Honourable WILLIAM NAPIER, GEORGE WILLOUGHBY HEMANS, Esq., and WILLIAM HOPE, Esq., called in; and Examined.

The Hon. *W. Napier*, *G. W. Hemans*, Esq., and *W. Hope*, Esq.

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394. *Chairman*.] WILL you give the Committee some information as to the scheme which has been proposed by yourself and Mr. Hope for the utilisation of the sewage of the metropolis?—Perhaps I might be permitted to say, at once, that although holding myself completely responsible for the evidence that may be given by my associates in the matter, still Mr. William Hope, my colleague in this undertaking, has so much more knowledge of the scientific details than I have, that although I am perfectly ready to answer any questions that may be put to me, I should prefer, and, I think, it would be more for the convenience of the Committee, that Mr. Hope should give any evidence which may be necessary.

395. Cannot Mr. Hemans answer the scientific questions?—I think that the question as to the agricultural value of the sewage is so intimately associated with the whole of the question, that it would not be in my power, even with the great advantage of Mr. Hemans's assistance, to do that justice to the undertaking, and to give that information to the Committee, which Mr. Hope is in a position to do.

396. (To Mr. *Hemans*.) Will you be able to furnish information as to the engineering part of the scheme?—I think I should be quite ready to explain to the Committee the whole of the engineering details, and the estimates; and Mr. Hope has made himself familiar with the commercial part of the question.

397. You are the engineer to this proposed company, are you not?—Yes.

398. (To Mr. *Napier*.) When was your scheme sent in to the Metropolitan Board of Works?—In 1861.

399. Was any similar plan embodied in a Bill in the year 1852?—We had no plan at that time.

400. Are you aware whether any similar plan was brought before the House in the year 1852?—I am not aware of that.

401. (To Mr. *Hemans*.) Are you not aware of that?—I am aware that a plan was deposited, and that an Act was obtained for reclamation on the Essex coast; but that did not, as I believe, involve any irrigation or adaptation of sewage to that reclaimed land. The plans were lodged, and the Bill was got for reclamation.

402. And did the Admiralty report upon that plan?—The Admiralty reported upon the plan, I believe, favourably; in fact, the Act passed, and it would not have passed unless the Admiralty had approved of it.

403. (To Mr. *Napier*.) Did Mr. Hopkins send in a report adverse to your scheme just before the Board met on the 7th of February 1862, to consider whether they should grant a concession of the sewage to your company?—Personally, I am not aware whether Mr. Hopkins did or did not send in any such report.

404. (To Mr. *Hope*.) Can you state whether that was so?—I can answer in the affirmative, he did do so.

405. Are you aware that the Board ordered Mr. Hopkins's Report to be printed?—That I cannot say.

406. (To Mr. *Napier*.) Are you aware whether or not that was so?—I do not know.

407. (To Mr. *Hemans*.) Can you answer that question?—I think they did; I know I made a reply to the Report.

408. (To Mr. *Hope*.) Was the concession granted to you?—The Main Drainage Committee of the Metropolitan Board of Works, which is a Committee of the whole Board, adopted it, by a resolution of the 10th of January 1862.

409. What action did the Board take upon that?—The Board postponed the discussion in consequence of the Parliamentary Committee of 1862; notice of motion for the Committee was given on the 6th of February, the day before that discussion was to come on in the Metropolitan Board of Works, and the further discussion of the question by the Board was adjourned in consequence of that motion.

410. (To Mr. *Hemans*.) Did you put in an answer to Mr. Hopkins's Report on 13th February 1862?—I did, and it was printed by order of the Board.

411. Had the scheme been previously withdrawn?—The deposit of the money had not been made, and consequently the scheme dropped for want of a concession of the sewage.

412. Was

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W. Napier,
G. W. Hemans,
Esq., and
W. Hope,
Esq.

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412. Was that before you put in your answer to Mr. Hopkins?—Whether it was before that or not, I cannot tell; but the scheme dropped for want of a concession, the money deposit not having been made.

413. Did the Board print your letter?—They did.

414. Did Mr. Hopkins write a reply to it?—I think he did, but I am not sure that I saw it.

415. Was that printed by the Board?—I cannot say; I rather think so; but I am not positive.

416. (To Mr. *Napier.*) You propose to construct a culvert 10 feet in diameter, and 37 miles long, with two branches seven and eight miles long respectively; is that so?—The branch, on one side of the River Crouch, has been withdrawn.

417. But with regard to the plan and tender which you deposited with the Metropolitan Board of Works, is not that the case?—It did contain two branches, but as to the exact dimensions of the tunnel, I should prefer Mr. Hemans to state that.

418. (To Mr. *Hemans.*) Will you state to the Committee the diameter of the tunnel and the length of it?—I can describe the whole scheme in a few words.

419. Will you state whether you intend to utilise the sewage on the north side?—On the north side solely. The red line on the plan represents the culvert, and the commencement of that is at the Abbey Mills; the intention was to take the whole of the sewage of the north side of London at the Abbey Mills, at the level to which it is to be worked by the Metropolitan Board of Works.

420. What level was that?—I forget the number of feet above the marshes, but it is considerably above the marshes at Plaistow.

421. What height would it be with regard to the Trinity datum at high water?—It is five feet above Trinity high water mark at the point of discharge. After taking it from that level, we proposed running a culvert of 10 feet in diameter for a distance of nine miles, and with a fall of nine inches per mile, until we reached a point where a reservoir could be made; at the ninth mile it was intended to make a reservoir, and to lift the whole of the sewage again 24 feet, and then to continue the discharge by a 10 foot culvert as before, sometimes on an embankment, and sometimes in tunnel, until it reached the existing sea wall on the Maplin Sands. The culvert was to be covered the greater part of the way, but on reaching Foulness it was intended to be open.

422. Mr. *Caird.*] How many miles is it altogether in length?—Forty-four miles in all. On arriving at the Crouch, one branch was to be thrown out to cross the River Crouch, and to cross the Dengey Flats, and the other branch went to the Maplin Sands.

423. *Chairman.*] Were those branches to be covered or open?—The culvert would be covered until it reaches the fork of the two branches, and at or near to that point it begins to enter open channels on both branches.

424. Are those branches seven miles and eight miles long respectively?—The north branch is a little more than eight miles long, and the south branch forms part of the main line.

425. Would not their being open create a nuisance?—There is no population in that district, and it was not considered that it would create a nuisance.

426. If there were a population, and if there were dairy farms, would it not create a nuisance?—In a running channel in the open air, if there were a dense population, no doubt in hot weather there might be some amount of nuisance; but I think that the means of the Company provided in the estimate would suffice to put a cover over it, if necessary.

427. Still, in your tender, did you not state that they were to be open?—In the tender it was stated that they were to be open.

428. The effluvium would be as great if there were but few people living there; and if the population increased, would they not have to suffer that nuisance?—The nuisance would be the same, of course, to a few as to a larger number; but if it did exist, it is proposed that we should cover it.

429. How many acres of sand did you propose to reclaim?—The Dengey Sands would have contained about 8,000 acres, and the Maplin Sands about 12,000 acres; but the acreage on the Maplin Sands would be considerably increased beyond what is shown on the plan, by taking in a portion which is reserved for artillery practice. I think that that is a good deal larger than is necessary for artillery purposes.

430. What is the total acreage of land that you propose to reclaim by this wall?—As shown on those plans, it was 20,000 acres.

431. What will be the total cost of this culvert, including both the construction and the purchase of the necessary land?—In round numbers, as it stood on that plan, the culverts and channels were estimated at 1,217,382 *l.*; the pumping establishment was estimated at 100,000 *l.*; the contingencies at 131,738 *l.*; and the land, the greater portion of which would not be occupied permanently, but would be covered in again, was taken at 50,000 *l.*; making a total of 1,499,120 *l.*, exclusive of the enclosure of the sands.

432. But what would the culvert cost altogether?—The culvert alone would cost 1,217,382*l.*, but including the land, and contingencies, and the pumping establishment, it may be taken as a million and a half in round numbers; it is very little short of that.

433. In your proposition to the Metropolitan Board of Works, do you not state that the estimate would be 2,000,000 *l.*?—Yes, the 2,000,000*l.* is made up by half a million which would be required for closing the embankment.

434. Will the culvert be carried by a uniform slope after passing that pumping station of yours?—Yes.

435. From that point, will it fall by gravitation only?—The whole principle of the scheme is gravitation, from one end to the other.

436. Do you mean from the pumping station at Abbey Mills?—Yes.

437. What fall will there be?—The fall will be about 24 feet to the edge of the River Crouch, and after that it will be six feet, or about 30 feet altogether.

438. That is not quite a foot a mile, is it?—It is nine inches a mile.

439. Do you think that the flow of the sewage will be so rapid as to prevent any deposit of the heavy matters in suspension in the sewage from taking place in the culvert?—Yes, I think so; I think there will be very little heavy matter. In consequence of the double pumping that it will have undergone, I think that all the heavy matter will have been broken up, and mixed with the water; in fact, there can be no lumps of anything.

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440. You are aware that there is a sort of mud in suspension in the sewage?—Of course.

441. Would not that be deposited in your culvert?—No, I believe not.

442. You stated, did you not, that the culvert would be sometimes below the level of the ground and sometimes above the level of the ground?—For a good many miles the culvert will be above the level of the ground, for the purpose of giving lateral supplies of sewage to the farms.

443. In your first tender, did you propose to give a supply to farms on the way?—Yes, it was intended to give a supply to farms on the way; at least, that was my report to the promoters of the scheme.

444. Is it shown on your plan that the culvert runs in tunnels in some places?—The plan does not show it distinctly, but I have the sections here which show the formation of the culvert at different points, both in cutting the embankment and in open sections, and I can explain that to the Committee, if they desire it.

445. Is that marked in the plan that you deposited?—The tunnels are marked, but the covered portions you might not very distinctly ascertain, because there is a double line drawn, showing the course of the work throughout; I should require to explain where the open parts begin, and where the covered parts begin. It may be taken generally that it is entirely covered, and open in the two branches.

446. But does the culvert run below the surface of the ground in places?—Yes; the culvert is for three-fourths of its whole length below the surface of the ground around it.

447. You propose to put the sewage of the north side of the metropolis on to about 20,000 acres of the Dengey Flats and the Maplin Sands, do you not?—Yes.

448. Did you apply to Parliament in 1862, for powers to enclose those sands?—The power to enclose the sands was in the same Bill to which those plans were attached, and in consequence of our not obtaining a concession of the sewage, the whole project was put in abeyance.

449. Do those plans show that you propose to enclose the sands by a sea wall, the embankment running out to a distance of two and a-half or three miles, and then running parallel to the shore for four miles?—That is what the plans show.

450. Then at about the eleventh mile of the wall, at Foulness Point, it would be, according to the plan, about four miles from the shore?—I think that would be about the point.

451. Those sands are covered, are they not, at high water?—Those sands are all covered at high water.

452. What is the total length of the wall?—On the south side, the total length of the wall is about 15½ miles; and on the north side, 10 miles and a few chains.

453. What acreage is inclosed by the wall on the Maplin Sands?—Between 11,000 and 12,000 acres; I believe that it might be made 12,000 acres; but it is a little less than that on the plan.

454. The wall on the Dengey Flats is about two miles out from the shore, is it not?—It is about two miles out from the shore.

455. Would the total length of that wall be a little more than 10 miles?—Yes, that would be a little more than 10 miles in length.

456. And that would embrace an acreage of how much?—It may be taken as 8,000 acres.

457. Then both walls would be about 26 miles in length, would they not?—Both walls would be nearly 26 miles in length.

458. Are there any other walls besides those?—There might be, and would be, cross walls constructed in the progress of the work, but they would be of a temporary nature; and they are not necessary to be shown on the plan.

459. What are those cross walls for?—To make the work safer during its progress, so as not to have too large an area exposed to accidents.

460. Would that be their only use?—They would prevent any further damage that might arise, in case of any accident to one part of the works. Sea-walls occasionally have breaches; and by dividing any large area into portions, you may protect the rest, in the same way as the bulkhead of a ship acts.

461. There appear to be some streams flowing out from Foulness Island on to those sands; would you not have to provide for the outlet of those streams?—Yes, certainly, we should have to provide for the outlet of the streams.

462. Would you not have to provide walls on both edges of those streams?—No. I may mention that on the Maplin and Dengie Sands the whole of the coast is warping up gradually and steadily; the inside is all under high water mark, and the actual level of the sands, or the slob, on the outside is higher than it is on the inside; the consequence is, that those streams are now taken through holes and valves in the sea walls, and then they pass out and run in open channels. All those streams would be taken in catchwater drains, and delivered at convenient points through our sea-walls.

463. Would not the sea come back again?—No, the sea is stopped by the valves. They occasionally admit the sea purposely, in order not to have the land too dry.

464. Then do you not intend to provide any walls for that?—It is not at all necessary, because we should provide catchwater drains, and deliver those streams at convenient points by traps and valves.

465. Foulness Island was reclaimed from the sea, was it not?—The whole of Foulness was formerly below high water mark.

466. Mr. Bazalgette stated that it was at the level of half-tide; is that the case?—Somewhere about that, I should say.

467. Was the island reclaimed by that warping process that you have described?—Yes; all the banks on the Essex coast, as far as I can trace their history, have been made out of the materials of the adjoining slob, or sands; and they have been put into form, in some cases, and clothed with stone, as I propose to do in the case of my embankments. In other cases they have been merely faced with sods.

468. Was the slob brought down the River Thames and the River Crouch, and deposited there by the tide?—There is an immense amount of deposit there from the Thames, the Crouch, and the Blackwater. The charts all show that the whole of that shore is growing steadily and regularly; it is pushing out to a great extent.

469. At what rate is it pushing out?—I cannot tell exactly, but I should not be at all surprised to find out that those walls which I laid out a year

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year ago would now require to be a foot lower, and that the sands would be a foot higher.

470. When the deposit has taken place on the sands, after a certain number of years, do you advance the wall out to seaward of that slob?—That is a different operation altogether. That warping is a gradual, cautious operation, consisting of putting obstructions very much below the level of high water, which only catch the deposit at ebb-tide; it is a very different thing from making a sea-wall to enclose the water, which is always raised considerably higher. I think that if the Committee will allow me to explain that, I could describe the way in which I have made embankments of this nature in other places.

471. What is the rate of the accumulation of this slob; is it many years since Foulness Island was under water?—I am not up at this moment in the dates, and in the history of those enclosures from time to time, but there are evident marks of enclosures; there are parallel walls, which have kept out the sea years ago; some of them have been made within the last 10 or 12 years, on the Dengy Flats.

472. At what rate do they advance from where the walls were before?—Not very considerably; they have only been done by proprietors in a partial way, in front of their own frontages, but nothing very considerable has been done. In fact, the operation is only one of taking advantage of the most convenient high-levels of the slob opposite the farms, where the farmers wished to do it.

473. The Admiralty Report states that Foulness Island was reclaimed at a period beyond the memory of man; is that true?—I cannot state what was the period of the reclamation of Foulness Island.

474. And, in fact, the chart of the year 1744 is very little different from the present chart?—I dare say that is so.

475. Then, in 100 years, there is very little accumulation?—The accumulation has been enormous hitherto on the Dengey Flats. Out of 7,000 acres, there are 2,000 or 3,000 acres that have acquired a very considerable deposit of rich mud.

476. What depth of soil is there above the sand in Foulness Island?—So far as I have examined the matter in Foulness Island and in other places, I have not seen more than three or four feet of soil.

477. Is there as much as that?—Yes; I think there is quite three feet.

478. Are the present embankment walls, which go just at the edge of the sands on the land-side, built on that soil, or do they go through the soil into the sand?—I have never opened them down to the bottom to see how that is, but I suppose that those who built them would do as I am doing myself; that is to say, they would make this embankment on the mud, and allow it its mean proportion of subsidence.

479. Are they large walls?—Yes; they are four or five feet thick at the top, and their width at the bottom would be 30 or 40 feet.

480. How high would the top of those walls be above high water mark?—The top of those walls will run from four to five feet above high water mark; in some places it would not be quite so much as that, but they are intended to be four or five feet above high water mark.

481. On the sea-side of the wall there are saltings, are there not?—In the Dengie Flats there are, to a great extent, but in the Maplin Sands the saltings are much smaller in area.

482. Outside the saltings, is there not a long shelving sand running three miles out to sea?—The Maplin is almost entirely of sand; near the shore there is a thin coating of clay, and the saltings are pretty thick; there may be three or four feet of mud, and then after that there is a thin coating of clay, and then it is sand.

483. If there were this long shelving sand, would not that form a sort of breakwater for the present walls against the force of the waves?—The greatest safety that there can be for an embankment is to have a sufficient foreshore; that breaks the force of the waves, and is a great element of safety.

484. Then, supposing that there were occasion for it, those sands are a great element of safety to the present walls?—They would be, if necessary, but there is no requirement for them. If the present walls were in any risk whatever, no doubt those sands would be a great protection to them.

485. Would they not be a protection against the German Ocean?—Yes; there are miles of those sands that form a breakwater, even outside the walls that we propose.

486. By this map, which has been laid before the Committee, it appears that you build your walls quite at the edge, or very nearly at the edge, of the sands; is that so?—I think that the Government map which I have here would show the plan better. The River Thames, the River Crouch, and the River Blackwater, all deposit in this direction (*describing the same*).

487. What is the depth of the water on the Barrow Sand?—I suppose that the Barrow Sand is dry at low water of springs, and that when the springs are in, there may be 12 or 13 feet of water.

488. That is about seven miles out from the edge of your embankment, is it not?—It is about that; then there are further banks; the whole of that shore is warping up.

489. How deep is the sea at spring tides along the line of your proposed wall?—I have taken it at an average depth of from 11 to 12 feet; in some parts it would be more, and in other parts it would be considerably less, but an average of 12 feet would be rather a large average to take.

490. In some parts, would it be as much as 20 feet?—For short distances, I dare say it would; but there would be no difficulty in encountering it.

491. What height of wall must you have to prevent the waves of the sea from getting over?—Six feet.

492. Would not the sea when it came up loosen the sand beneath your wall, just as when a ship is stranded it loosens the sands where the ship lies, and allows the ship to subside?—No, certainly not; that appears to me to be the fallacy that misled Mr. Hopkins; he imagines that our sands are quicksands, and that we must penetrate through them, and get down to a solid foundation; but there is no danger from the quicksands; nothing of the kind has ever occurred in making embankments to a large extent. In the first place, I may explain that if a small object like a boat is left on the sands, the tide coming and going about it will gradually work a hollow around it, but when once you make an embankment of say 150 feet on a regular line, a totally different thing takes place; from that moment

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moment the embankment begins to rise by the deposit which occurs, and forms a foreshore on the outside. It is universally known among engineers that what takes place then is totally distinct from, and has no analogy whatever to, the case of a small obstacle placed in the midst of a great expanse of sand.

493. But do not vessels now subside into those sands and disappear?—I am not aware that that is so; it is very probable and quite possible that that may be so, but that has nothing whatever to do with the question of engineering.

494. Are those sands not quicksands?—I do not consider them to be so, but if they were so that would not interfere with the operation of the embankment.

495. You would not say that they are not quicksands?—I would say that a large proportion of them are not quicksands. The artillery at Shoeburyness drive over them with heavy guns and caissons, and things of that kind, and I have driven over them myself very often in various places, and there is no danger.

496. Is it not the case with regard to quicksands, that at low tide you can drive over them very well, but that when the tide begins to rise the water works its way through underneath, and then you sink into the sands?—That is so.

497. Is it not the fact that the circumstance of the artillery going over the sands at certain times would not prove that they are not quicksands?—They go over them when there is a good deal of water there, but all light sands that are saturated with water in that way may be treated as quicksands.

498. But do you hold that you could build a wall on those sands?—I am exceedingly anxious to show not only that I can do it, but that it has been done.

499. Has it been done on these sands?—No, those sands have never been tried.

500. How do you mean, then, that it has been done?—It has been done on sands 60 or 70 feet deep at Morecambe Bay over an extent of seven or eight miles. If the Committee will permit me to read a few extracts I can show that it can be done with great ease, and it will dispel a great deal of the illusion which exists with regard to those works. I may state those works at Morecambe are not of my construction, but I have made in the Bay of Malahide, on the Dublin and Drogheda Railway, works precisely similar to these works. When the sands there are puddled with water you can make them quicksands. This is a description of the estuaries of the Kent and Leven in Morecambe Bay: "Morecambe Bay is an arm of the Irish Sea, situated to the west of Lancaster; its average width is about 12 miles, and it extends about 17 miles inland from the mouth. Its dangers are well known to all who travel the over-sands' route, on account of the constant shifting of the fresh-water channels, and the treacherous nature of the sands, more especially during freshes in the rivers. A great portion of the bay being left high and dry at low water, its reclamation from the tides has often been talked of, and whilst being the subject of careful inquiry, the project has elicited from those most worthy of confidence very favourable recommendations. In 1837 the late Mr. George Stephenson reported on the practicability of constructing a railway embankment across it, and at the same time reclaiming from 20,000 to 40,000 acres of land. Mr. Hague also made a similar report proposing to reclaim 40,000 acres." "The works were partially commenced in May 1853, but owing to the scarcity of workmen, and the want of accommodation for them in the neighbourhood, it was only in September of that year that they were in full operation." "The line of embankment then extends directly across the mouth of the Leven estuary, and as, in making the borings, nothing but sand was found to a depth of 30 feet, and in one instance where the boring was carried to a depth of 70 feet the material continued the same, it was necessary to take great precautions for the work, particularly as a large volume of water descends the river channel, the River Leven, above this point, receiving the rainfall from an area of about 109,120 acres, including the drainage of Coniston and Windermere Lakes." I should be glad now to read to the Committee a description of the way in which the work was done, because it will show the mode in which I propose to perform the works in this case. "The railway embankments are being formed of the sands taken from the seaward side of them, and owing to the high price of labour during the last season, two-wheeled carts have been used, instead of wheelbarrows, and up to 14 feet above the sands no difficulty has been experienced in carting. The *modus operandi* is to carry on such lengths as can be raised to a safe height, puddled and pitched, between spring tides, the open end of each length being laid to a flat inclination, up which the material for topping off is carted. The end is then protected during the springs with clay and stones. In this manner from 10 to 11 lineal yards of the embankment have been formed per day, or at the rate of a mile in six months from one face." This operation has been actually performed, and the railway is now running on those Morecambe Bay sands, which are precisely similar to those with which I propose to deal in this case. I have here another report two years after, stating that in those two years nothing had been disturbed.

501. Then are you of opinion that you can build those walls on the Maplin Sands?—Yes, and this is a proof of it.

502. What will be the breadth of your wall at the top?—The breadth at the top would be four feet, and at the base it would be 78 feet, for the average section.

503. What height would the wall be?—The average height I take at 18 feet from the base to the top.

504. In the place where the water is 20 feet deep, what would be the height of the wall?—In every case the wall would be six feet above the level of the tide, so that where the water was 20 feet deep the wall would be 26 feet high.

505. Of what materials would you make the wall?—What I have just read is a description of what I intend to do here and what I have already done in the estuary of Malahide. The sand would be excavated on the seaward side of the wall, it would be put in with wheelbarrows or anything of that sort to form the core of the embankment, on the face of that would be a puddle of clay 18 inches thick which would have to be boated there from the shore, and over that would be a coat of chalk or Kentish rag on the seaside and one of sodding at the top also on the seaside. On the inside the puddling alone would suffice.

506. Would that be permanent?—That is the construction which has been adopted in

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Morecambe Bay Works, and on the estuary which I have described in Ireland.

507. Have you had any borings made, to know the depth of those quicksands?—I do not care if it is 100 feet deep, it makes no difference in my construction at all; borings were made, but I did not go down above 10 or 15 feet deep.

508. Over those sands would you discharge the sewage of the north side of the metropolis?—Yes.

509. I suppose you are aware that in eight hours out of 24 the half of the sewage flows?—I am aware that there is a larger proportion at one period of the 24 hours than there is at another.

510. The dry weather sewage of the north side of the metropolis is stated to be 10,000,000 cubic feet daily; is that correct?—That is the statement which I took from the Metropolitan Board of Works.

511. That would be 500 cubic feet per acre daily, would it not, over the 20,000 acres?—Yes, it would.

512. Then if the half of it flows in eight hours, that would be 250 cubic feet per acre in eight hours?—Supposing the half to come in eight hours it would be 250 cubic feet.

513. (To Mr. *Hope.*) What would be the thickness of this per acre per annum?—It comes to seven feet per acre per annum.

514. (To Mr. *Hemans.*) Do you confirm that?—On 12,000 acres only it would be seven feet thick, but on 20,000 acres it is four feet per acre per annum.

515. Two hundred and fifty cubic feet in eight hours would be two and a half inches depth of sewage in eight hours, would it not?—I think that it would be about one-fourteenth of an inch; the acre contains 43,500 square feet, or thereabouts.

516. How many tons of sewage are there from the northern side of the metropolis in a year?—168,033,115 tons.

517. How much would that amount to an acre in value?—That depends upon what you take it at. I have not gone into the commercial value of the sewage at all; I have confined myself to the engineering part of the question.

518. (To Mr. *Hope.*) Will you state what is the commercial value of the sewage per ton?—The value taken by most scientific men appears to be about 1 *d.* per ton, but it is very difficult to say what the value is because it is not a thing that you can value like guano or any other portable manure.

519. The value given in the Report of the Metropolitan Drainage Committee is 2 *d.* per ton; are you aware of that?—No.

520. (To Mr. *Hemans.*) It is the dry weather sewage that you are speaking of, as being 10,000,000 cubic feet; but how do you dispose of the storm overflow? — What storm overflow there is, must go into the Thames.

521. Are you aware that that will carry an immense amount of sewage with it into the Thames?—That is the system of the London drainage; we have nothing to do with that.

522. But supposing that it was the object of Parliament to get rid of the pollution of the streams, would that be permitted?—The storm overflow is confined to a few days in the year; it is not considered necessary to provide specially for that.

523. Do you provide for the usual average rainfall?—The rainfall is perfectly immaterial in our scheme; it is so small, as compared with the sewage that we have to deal with, that it is perfectly immaterial.

524. Is not the rainfall of the metropolitan area equal to 169,683,510 tons in a year?—I have never calculated what the rainfall is; but the rainfall can only go into the sewers, and when the sewers are full, it must be discharged into the Thames; we take whatever the sewers give to us.

525. And you estimate that at only 10,000,000 cubic feet per diem?—I estimate that at 10,000,000 cubic feet.

526. (To Mr. *Hope.*) By whom is that estimated?—That is the estimate of the engineers of the Metropolitan Board of Works.

527. When that amount of sewage is put upon the sand, do you think that the water would drain away, and leave the mud, or the feculent matter, on the sands?—We shall not trust entirely to gravitation for the drainage of the sands.

528. But when you have got it to the sands, what will happen?—The sands will be fertilised by the action of the sewage.

529. But what will become of the water?—The water will be pumped, so far as gravitation is not sufficient, by the usual power that is employed.

530. You are aware, are you not, that 6–7ths of the value of the sewage is in solution?—I believe that that is so.

531. Then would you not be pumping out 6–7ths of the richness?—No, that would be absorbed by the crop which is raised on the sand.

532. Is there any crop there now?—None whatever.

533. Then at present, would not your pumping put out 6-7ths of the value of the sewage?—No, because there would always be a crop growing on the sand.

534. But there is nothing growing there now?—At present it is covered by salt water; but when we have reclaimed it from the sea, we should grow crops upon it; we should never fertilise it, except for the purpose of growing crops; there would be a succession of green crops always growing.

535. Is there any soil there?—Scarcely any at all.

536. Would you grow crops on that pure sand?—It is precisely in the same state as the Craigentinny Meadows, near Edinburgh, which are composed of sand on the sea-shore formerly blown above high-water mark; they were shifting sands which were blown about by the wind; they were then levelled and irrigated with the surplus sewage about 40 years ago, and there is now only half an inch of black deposit on those Craigentinny Sands, showing therefore, that the whole of the fertilising property of the sewage is absorbed by the plants growing on the sand. The average rent of that land is now 26 *l.* or 28 *l.* an acre, and the portions of it, which get the greatest supply of sewage let every year for 40 *l.* an acre.

537. (To Mr. *Hemans.*) Would there not be a head of 20 feet of water outside this embankment in some places?—For short distances, there would be 20 feet of water for a short time.

538. Are you sure that the water, when the tide rises, will not come in through the sand below, and fill the reclaimed land with sea-water again;

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again ?—There is not the slightest fear of it; the whole of the embankment will be puddled on the side of the sea. The sands have been tested by careful experiment as to their bearing powers, and it has been found that these sands, although they are quicksands, have a capability of bearing power of five tons to the square foot; the embankment will produce a pressure of about a ton and a-half to the square foot, or something less, and consequently those sands will be, under this heavy weight, quite sufficiently compressed to prevent any influx of water.

539. Will not the water have to be pumped out for whatever drainage is to take place ?—There will be catch-water drains with outlets and valves, and when the rain water happens to fall in surplus quantities, the pumping power will be used to complete the drainage so as to cause the filtration of the water through the sand.

540. (To Mr. *Hope*.) What rent do you offer for the sewage ?—We offer half the profits.

541. Do you name any sum ?—No.

542. (To Mr. *Hemans*.) Did Mr. Bazalgette report in favour of this scheme ?—He reported, and I think that his report was rather favourable.

543. He stated to the Committee that he did so without visiting the locality; did you lay your plans before him ?—I laid all those plans and calculations before him, and he did not find it necessary to go down.

544. (To Mr. *Napier*.) In this small book which contains a letter from yourself and Mr. Hope to Mr. Thwaites, dated 29th April 1864, you say, "We are reminded by Mr. Pollard's letter of the 14th April of the promise which we gave to the Board at our interview on the 23d of February last;" who is Mr. Pollard ?—He is the clerk of the Board, I understand.

545. The clerk of the Metropolitan Board of Works communicated with you, and that gave rise to this letter; is that so ?—We have been in communication since we withdrew the financial part of our proposition.

546. It appears that you made a promise "on the 23d of February last to supply the Board with further information as to the practical carrying out of your scheme"?—Mr. Hope did so.

547. Were the Metropolitan Board of Works of opinion that you had not given them sufficient practical details ?—I should infer that that was so.

548. Although they had reported in favour of your scheme ?—But a long time had elapsed since then, and they wished for further information.

549. You state that you have found it "wholly impossible for either yourself or Mr. Hope to devote to the subject the time and attention which it deserves"?—That was within the short time that we had to do it in. Both Mr. Hope and myself have considerable occupation, and we could not, within that time, give the Board of Works the required information.

550. (To Mr. *Hope*.) Was that since they reported in favour of your plan ?—Since the 23d of February. I have been absent from England almost the whole of the time.

551. You state here, that in consequence of the report of the Parliamentary Committee, you have come to the conclusion that you "may in reality obtain from an intermittent application of sewage over a more extended area, a larger pecuniary profit"; is that your opinion still ?—Yes.

552. Do you expect to get a larger profit by extending the area of your operations ?—We expect to realise a certain sum for the water in which the manurial value is contained, as well as for the sewage itself.

553. You state that "The idea of distributing the whole of these 10,000,000 cubic feet daily, through an immense complicated net-work of pipes, to be applied to the soil through the hose and jet, is one that no practical man can for a moment entertain." Do you think that no practical man would have the notion of distributing through a net-work of pipes ?—I should say, certainly not.

554. Then what plan would you propose ?—Allowing the sewage to flow over the land by gravitation. The system of the hose and jet requires the whole body of sewage to pass through the hands of men who must necessarily work the hose and jet.

555. Would you allow a cataract of sewage to come out of the culvert and flood the county ?—Not exactly a cataract; it would flow out gently.

556. How far would it flow ?—The land would be thrown up into long, low ridges; and at the top of each ridge there would be a gutter composed of a clay tile with a double lip; this lip extending two or three inches over the ridge on each side.

557. Have you looked at this report of the Board of Health of 1852, in which they state that they have come to the conclusion that the gutter system cannot be advantageously adopted, and cannot pay ?—I have not seen it; but I think that the practical answer to that would be that it pays uncommonly well; that it pays 40*l.* an acre at Edinburgh.

558. You go on to say in your letter that, "The capital required for the pumping machinery and for the thousands of miles of pipes, and the daily labour and expense of application, would be so enormous that, even could it be obtained, no return that the land could give would pay the cost"; is that your reason for that statement ?—Yes.

559. Could you give the Committee any notion of the value of the sewage to the ratepayers ?—I state the value of the sewage in an appendix to this letter. The value of the chemical constituents of the sewage appears to be about 6*s.* per head per annum of the population.

560. What authority have you for stating that ?—I give the authority in the appendix; there have been a great number of different estimates and analyses from careful experiments and observations.

561. You mention Mr. Hoffman among those gentlemen; does not he give a higher estimate than that ?—He gives a higher estimate for sewage from particular sewers, I think, but his general evidence is the other way.

562. Do you think that you would procure a greater return for your outlay in the extra crops on an extended area, or on a smaller area ?—I think that you might get a larger return from a more extended use, provided that extended use was not carried to such a point that the machinery employed would eat up the greater profit.

563. Do you propose that the fluid shall be brought by gravitation from the culvert ?—That is the system that we propose.

564. Do you propose to have pipes from the sides of the culvert ?—Yes; pipes or conduits.

565. Is that according to your new tender, or your

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your old tender?—According to our new tenders; we contemplated it originally also, but as we were very doubtful whether we could induce people to see the value of the sewage, we based our tender on the supposition that they would not see the value of it at first.

566. Then you have altered the old tender, and you now intend to carry pipes on each side of the culvert?—We intend to carry pipes of some sort or other in proportion to the lateral area to be supplied. In some places it might be a pipe to supply meadows, and in others it might be a conduit to supply several farms.

567. Do you provide for a constant flow of the sewage all day long?—All day long, and in all weathers, and in every season of the year.

568. You state this also in your letter, "We have nevertheless come to the conclusion that this system, so perfect in itself, may be made still more remunerative if supplemented by others, and that though this system gives out the full value of the fertilizing properties contained in the sewage which no other system, taken by itself, will do, yet we see, paradoxical as it may appear, that under certain circumstances a fictitious value may be obtained for the sewage by its partial and temporary use on soil not wholly devoted to it." What do you mean by that?—That is, in dry weather, by securing the liquid to the farmers, and to obtain some return for the water as well as for the sewage. The water is valuable for ordinary irrigation even without the sewage in it.

569. But will you explain what is the fictitious value which will exceed the real value?—The value of the sewage is the value of the manure which is contained in it, but in dry weather it is evident that the water is of value also.

570. Do you mean that they would give you a higher price on some days than on others?—Certainly.

571. You state that your scheme, to a certain extent, will be an experiment; in what way will it be an experiment?—I explained that in the preceding paragraph. It is no experiment as to the amount of produce to be obtained, but it is an experiment as to the value which may be obtained for that produce.

572. Then you do not know what the returns will be?—We know what the produce will be, but not what it will be in value; it depends on the amount of competition to which we shall be exposed from the dairy farmers at first starting.

573. You give up the Dengey Flats, and confine yourselves to a smaller area, do you not? Yes; that we have done on both practical and scientific advice.

574. For what reason was that?—The surface of the Dengey Flats is exceedingly irregular, the mud is very deep and soft and sticky; and the manual labour of preparing it would be very expensive.

575. Were you not aware of that when you sent in your former tender?—We were; but as we did not contemplate the possibility of inducing farmers to take the sewage over any extended area on the route, we thought it desirable to obtain possession of the other piece of ground.

576. Do you mean that you merely intended to put it upon that ground, because you thought the farmers would not take the sewage between London and the Maplin Sands, but that now you suppose that the farmers will use it?—Quite so. Moreover, it is immaterial whether they take it or not, as we have a sufficient area in the 12,000 acres to utilize the whole of the sewage every day in the year, and in all weathers; and even if there were too much we could filter it so as to render it innocuous.

577. Does not this new plan reduce the area very much?—It reduces the area in our hands by 8,000 acres.

578. Then do you think that you will be able to utilize the sewage over an area of more than 8,000 acres between London and the Maplin Sands?—Certainly, because to one man we can sell one dressing a-year, and to another half-a-dozen dressings, perhaps.

579. Will you explain what you mean by this statement in your letter as to the capital:—"The share capital of the company may be indeed reduced to two-thirds of the cost of the main sewer from Abbey Mills to the present high water mark upon the Maplin Sands, and of the sea embankment necessary for the reclamation of this area, together with two-thirds of all expenses connected with these works." How do you mean that you will reduce it by so much?—We issue share capital for that amount.

580. What is it that will cause that great reduction?—The reduction is not quite so large as mentioned at first. The reduction will be on account of our abandoning the Dengey Flats and the sea walls to enclose them, and the branch culvert over the River Crouch, which involved an expensive syphon; but Mr. Hemans tells me that, on further consideration, he thinks that he can scarcely reduce the expenditure by so large a figure, and that the reduction will not be 500,000 *l.*, but 400,000 *l.*

581. You state then "The contractors' estimate for the engineering works; that is to say, the main sewer, principal irrigating channels, pumping machinery, and embankments, together with interest and management during construction, comes to 1,500,000 *l.*" You would now say 1,600,000 *l.*, would you not?—Yes.

582. What would be the rate of interest on the 1,600,000 *l.* That you will find in the appendix B, at the last page. I do not think that the debentures could be raised at less than five per cent.

583. At page 23, do you not state that the rate would be about 6 *l.* 14 *s.* per cent.?—No; that is for the rent charge, which would be created by the money lent for 25 years through the Lands Improvement and Land Securities Companies; those are not debentures.

584. You pay 6 *l.* 14 *s.* per cent. for 25 years, and for the rest you pay five per cent.; is that so?—The debentures would be five per cent., and a half per cent. would have to be provided to pay them off in 50 years.

585. But would not that amount to about 70,000 *l.* or 80,000 *l.* a-year for interest?—No; it would be 27,500 *l.* for 500,000 *l.* debentures, and 16,080 *l* for 240,000 *l.* rent charges.

586. Is that on a capital of 1,600,000*l.*?—The 1,000,000 *l.* is share capital, which divides the profits with the Metropolitan Board of Works.

587. Would not the shareholders have the profits?—The profit would be the interest; it would be something like 15 or 20 per cent. on the 1,000,000 *l.* of share capital.

588. Will the income that you expect to derive from the increased crops over this area pay all that money?—That is all stated in page 22 of the letter at the end of Appendix A.

589. You state that "The theoretical value of

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the manurial constituents of the sewage would be from 510,000 *l.* to 540,000 *l.* per annum, while the realisable, that is, in other words, the net value of 10,000,000 cubic feet per diem, at a penny a ton, would only be 422,452 *l.* 10 *s.* 5 *d.*, showing a loss of some 20 per cent., made up partly by actual loss, but chiefly, of course, by the cost of application." Is that paragraph the one you refer to?—It is at page 22, at the end of Appendix A.

590. Do you mean, by what you say at page 22, that you expect to get a rental of 40 *l.* an acre for this reclaimed land, and that in that way you could pay the interest on the capital?—I see no reason to doubt that we should get as much from these lands as is obtained from the Craigentinny Meadows at Edinburgh. On the contrary, I think that the return here ought to be a great deal better, because the growing season is a month longer.

591. Supposing that you had not to pay any rental for the sewage, and received a rental of 40 *l.* an acre, in that way you would be able to pay your interest, but not otherwise?—The return depends, of course, entirely on the value which is obtained for the sewage.

592. Do you remember that Mr. Hoffman has stated, and that those who made this Report on the Metropolitan Drainage, have corroborated that statement, that the annual value of the London drainage is 1,400,000 *l.*?—I have not seen the report to which your Lordship alludes.

593. If it were so much as that, you would hardly get a return for your outlay?—We should certainly realise the full value, whatever it might be.

594. If on starting you could not get 40 *l.* an acre for your sandy land, would you get such a return as that?—If we did not get 40 *l.*, we might get 30 *l.*; but we should not look for such a return for the first few years.

595. At how much do you estimate your expenses, and wear and and tear, and so on?—At 30,000 *l.* a-year.

596. You say in your letter, "Whether we shall be able immediately to realize this theoretical value of 434,025 *l.* a-year from the Maplin Sands when reclaimed, it is impossible to say," you seem therefore to have some doubt about it?—We go on to say, "As this must depend on the amount of opposition and obstruction offered on the part of the dairy farmers and traders; but on the other hand as it is our intention, at various points along the line of the main sewer, to irrigate a few sample meadows as an advertisement to the surrounding farmers of the fertilising properties of sewage, there is every reason to believe that we may, even before the expiration of the first season, be able to distribute a considerable portion of sewage over the farms nearest the conduit, and thus obtaining for this portion of the sewage a fictitious value, as we have already explained, the total pecuniary result realisable even the first year may, after all, not fall very far short of the theorectical value which we ought to obtain."

597. But you there seem to have some doubt as to whether you would realise the theoretical value; do you still entertain that doubt?—Certainly.

598. How long would it take to reclaim that land?—It would take the same period probably as to construct the culvert, that is about three years.

599. For that time, at all events, you would get no return?—During the construction of the works, there could be no return.

600. The theoretical value is the greatest value, is it not?—Certainly.

601. Then, how is it that you say that, "It is clear that the returns derivable from all sources must, for many years, continue steadily and rapidly to increase?"—Because at first we must tempt people to take the sewage, by giving it to them rather under its value; and we must also tempt the dairy farmers to settle on our land by giving them advantageous leases.

602. Then you go on to state that, "The one great and exceptional advantage of our original scheme for the application of the sewage solely to the foreshores of Essex is, that we propose to carry it altogether beyond the utmost limits of present habitation." Why do you give up that feature of your plan, if you consider that it is the one great and exceptional advantage of your scheme?—I go on to say, that "It is, in a great measure, applicable to our scheme as matured and developed, as it is still upon the same foreshores that we contemplate applying the main body of the sewage; and as the amount to be placed at the disposal of the farmers will be limited, and as they will generally avail themselves of it only in dry weather, it is in the highest degree improbable that any nuisance can arise from this more extended system which we now contemplate."

603. But do you propose now to carry it altogether beyond the utmost limits of present habitation?—No.

604. Do you intend to have pipes or conduits at the side of your culvert to carry the sewage out into the fields through which you pass?—Yes.

605. And that would be to a greater extent than 8,000 acres, would it not?—Mr. Hemans estimates that the area commanded would be 20,000 acres.

606. Does not that do away very much with the one great and exceptional advantage of your original scheme?—No, I think not, for this reason; the amount of sewage placed at the disposal of the farmers would be limited, and they would generally avail themselves of it only in dry weather when the ground would absorb it, so that it is in the highest degree improbable that any nuisance could arise from our more extended system.

607. Lord *Fermoy*.] (To Mr. *Hemans*). You stated, did you not, in an answer which you gave just now, that you propose to run your culvert partly under the level of the surface of the land, and partly above the level?—Yes.

608. And you stated that for three-fourths of the way it is under the level of the surface of the land?—Yes.

609. Can you give the Committee any idea how much it is under the level?—It varies from one foot to 30 feet. In part it runs entirely in tunnel, which is excavated, and then there is a tunnel which is first opened and then closed again. I think it is 30 feet under the surface, or perhaps a little more.

610. Is that for a considerable distance?—Perhaps for a couple of miles it may be as deep as that.

611. And then is it something less?—Then it varies according to the undulations of the ground. The embanked portions are, of course, to cross over the valley; but the general level is under the ground.

612. Wherever it is considerably under the level of the surface, I presume you do not pro-

pose to use it on the lands in the neighbourhood?—There would be no difficulty in doing so by pumping. The farms under which it passes might have shafts down to the culvert; and I have no doubt whatever that in time those shafts would be used with pumps.

613. Would not that be a more or less expensive job?—Of course there would be some expense, according to the lift that was required.

614. In point of fact, you cannot use the sewage by gravitation in any place where it is under the surface?—It is only contemplated now to use gravitation where we can command the surface.

615. Therefore, for three-fourths of your culvert, you do not propose to utilise the sewage by gravitation on the lands in the neighbourhood; is that so?—Just so.

616. We have, then, to limit the utilisation of the sewage by gravitation to the lands which you propose to reclaim, and to one-fourth of the distance of country through which the culvert goes?—Yes; but that one-fourth commands a very large acreage. I have made a rough calculation of it, and I find that it commands 30,000 acres. The whole of that would be about Foulness, and both of those arms, which are open channels, as in our original plans, are all above the level of the flats for 16 miles, and that would command 30,000 acres by gravitation; that is, leading it to a distance.

617. To what distance, on an average, will you go from the culvert to include anything like 30,000 acres for one-fourth of the distance that the culvert goes?—I see no reason why it should not be led two or three miles. At Croydon it is led a considerable distance from the reservoir; and I see no reason why to farms that can command a continuous run, it should not be led two or three miles inside ditches.

618. Assuming that it is led two or three miles, you would include an area of 30,000 acres?—I say that an area of 30,000 acres is commanded, and could be watered by this culvert.

619. Does that entail the necessity of your going with your side culverts further than two miles?—It does.

620. How much farther?—I have not gone into it in that detail. I can only say, that 30,000 acres would be commanded, involving the necessity of going two or three miles in some places.

621. With regard to those lands which you propose to reclaim, you have explained to the Committee the difference between warping and embanking; warping is, as you have explained, allowing the sea to come in at high tide, and to recede again?—Warping is laying slight obstructions to the ebbing tide, so as to catch the deposit by a slow process, and then, on the subsiding of the sea, you have a deposit.

622. In your case, you do not propose to do that, but to build an embankment right off, and thereby to have the sand pure and simple inside the embankment?—Just so.

623. Do you know anything of the embankment of the Craigentinny Meadows at Edinburgh?—No, I have not visited them.

624. Can you state whether that was done by warping, or by embankment?—I have not visited them; but I believe them to be, to a great extent, natural sands, blown up by the wind.

625. Were they acquired, or reclaimed by warping, or by direct embankment?—I think not.

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626. (To Mr. *Hope.*) Can you supply that information?—It was sand blown up above the level of high-water mark.

627. (To Mr. *Hemans.*) Your proposal with regard to these sands is to deal with them, in an agricultural sense, to work them and to grow crops upon them?—Certainly.

628. How do you propose to raise a surface for the purpose of growing crops on those sands?—There is no occasion whatever to raise the surface; the whole surface is now in the lowest parts three feet above low-water mark, and it is only necessary to keep out the sea in order to have it always dry. As regards the rain-fall, it would be taken off from Foulness, as it is now, through outlets or valves, and catch-water drains; but the sewage that we are going to deposit upon it would be too great to take off in that way, and it is proposed to take pumping power to a sufficient extent, so as to keep the filtration perfect.

629. Do you think that the sand with this sewage upon it would grow good crops?—It has been proved to demonstration to be so at Edinburgh; and those meadows which have been referred to yield a very large rent; they are perfectly pure sands; in fact, the professors of chemistry who examined the Maplin Sands and the Dengie Sands, rejected the Dengie Sands partly because they were too rich; they preferred a poorer sand as being better adapted to take the sewage through. The mud of the Dengie Sands was rejected as being too thick, and taking too long a time for the sewage to go through.

630. You stated, did you not, that you reclaimed or embanked the quicksands, as you call them, at Malahide?—I was the resident engineer under Sir John M'Neile at that time; that was 20 years ago.

631. Are the Malahide Sands quicksands?—Yes; they are the pure sands, and, when covered by the sea, all sands become quicksands; in fact, it is of no use to make a mystery of quicksands; there is no such thing as quicksands *per se.* When movement goes on in the water above the sand there is an oscillation of the sand; there is no other secret or mystery in quicksands. As I stated just now, the quicksands in Morecambe Bay, where those works were made, were 70 feet deep, and of a very treacherous nature.

632. Have you gone into the question of profits from your works?—I have not made that a part of my study at all; I have confined myself entirely to the engineering portion of it.

633. (To Mr. *Hope.*) You have stated that you estimate that your shareholders will reap a profit of from 15 to 20 per cent., and your estimate is based upon the assumption that you would divide the profits with the ratepayers of the metropolis; therefore you have estimated that the ratepayers of the metropolis would also reap a profit of 15 per cent.?—Yes; from 150,000 *l.* to 200,000 *l.*

634. That is to say, the whole work will give a profit of from 30 to 40 per cent.?—Yes.

635. Upon what is that calculation based?—It is based upon the experience at Craigentinny.

636. You stated, did you not, that the rental there is 40 *l.* an acre?—The calculations are on page 22 of my letter, which has been referred to.

637. You have stated that you expect to realise a rent of 40 *l.* an acre from your land?—Yes, if the whole of the sewage is applied to the 12,000 acres; but if only half is applied, we expect to realise 20 *l.* or 21 *l.* an acre.

638. Have

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638. Have you at all estimated how long it will be before you let your lands at 40 *l.* an acre?—It is not necessary to estimate it, because the experience at Craigentinny gives a positive answer. The first crop given upon this pure sea sand at Craigentinny was as good as the last, and sold for as high a price.

639. Then do you propose in your scheme to become farmers, and to till the 12,000 acres yourselves, or to rent them to other persons?—We should do both probably, in order to see which paid the best. There would be no farming in the ordinary sense of the word, because there would be only one description of crop, namely, grass of which from five to six cuttings would be obtained yearly.

640. Then do you propose to start off at once, by letting a portion, and farming a portion?—Yes.

641. And do you contemplate that you will obtain a rent of 40 *l.* an acre at the commencement?—Not quite so much as 40 *l.* an acre; probably, it would be impossible to get so much as that from people who have had no experience of it.

642. You propose, in this letter of yours, to make the principal part of your profit by turning it into dairy land?—We propose to turn the whole of the land into dairy farms.

643. But, as I understand, you have no safe basis to go upon, to enable you to calculate what extent will be rented, and what extent you will have to farm yourselves?—That, of course, will be entirely dependent upon the decision of the Board of Directors of the future company.

644. Have you made any estimate at all as to the plant which it will be necessary to use?—There is no plant necessary.

645. Do you propose to farm it without any plant?—There is no plant required in the way of hose and jet, and distributing pipes, and so forth.

646. But you propose to plough it, do you not?—No, it does not require to be ploughed; it requires simply to be prepared for the first crop, and after that, nothing more is necessary. It would probably be prepared by hand, and not ploughed.

647. Would it be done by manual labour?—By manual labour. That is estimated, together with cattle sheds and farm buildings, at 20 *l.* an acre, or 240,000 *l.* altogether, which we would lend to the company at the rate of 6 *l.* 14 *s.* per cent. per annum for 25 years, when the charge would be wiped off, and there would be an additional 16,080 *l.* a year for profit.

648. Do you propose to lend it to the company?—We propose to lend it to the company, who would be the landowners in this case.

649. Who is it that would lend the money?—The Land Securities Company, and they are willing to engage to do it at once.

650. Do you represent that company?—Mr. Napier and myself are both directors of that company, and we can therefore engage to lend the money.

651. Then, in point of fact, you appear here really in two capacities; you represent those companies who are to lend the money, and you also represent the promoters of the scheme?—We are the originators of the scheme.

652. You are, so to speak, the promoters of the scheme, and you propose to go to the public for capital?—Yes.

653. Is it the company with which you are connected who are the promoters of this scheme?—No, we ourselves are the promoters of the scheme, but in all probability the scheme would be taken up by a company in the City, of which I am manager, namely, the International Financial Society.

654. *Chairman.*] Is that a different society from those which you have just now mentioned?—Yes, we have in that way the machinery to provide the share capital, the Debenture capital, and the money to be lent upon the land.

655. Lord *Fermoy.*] Are you a professional gentleman; are you an engineer?—No.

656. You are not connected with anything agricultural, I presume?—No.

657. Then you propose, at any rate, to borrow money on the part of this scheme from those companies that you have mentioned, for the purposes of developing this improvement?—For the purpose of land improvement. The company which I first mentioned is the Lands Improvement Company, which is authorised by Act of Parliament to lend money for these purposes, and they issue their debentures through the medium of the Land Securities Company, which is formed for the express purpose of lending money to landowners, and of which the Duke of Marlborough is the Chairman.

658. You stated, did you not, that 2,000,000 *l.* is the amount of capital which you require to raise?—No, it would be about 1,600,000 *l.*

659. Is that for the reduced scheme?—That is for the reduced scheme, plus 240,000 *l.* to be laid out in the agricultural works on the land when it is reclaimed, and which would be paid off in 25 years.

660. (To Mr. *Hemans.*) Do you propose to go for a Bill for powers to make your culvert?—Certainly; it would be impossible to do it without an Act of Parliament.

661. You have two pumpings for the length of your culvert, have you not?—We have not two pumpings; the Metropolitan Board of Works have one pumping which we have nothing to do with, and we take it from their delivery.

662. Have you only one pumping?—We have only one.

663. But if you mean to utilise the sewage along the culvert for three-fourths of the way, must you not have small lifts for the farmers?—Where the top of the culvert is below the level of the ground, there would require to be lifts where the farmers are willing to pay for it.

664. What do you estimate to be the cost of the nine-mile lift?—I have assumed a sum of 100,000 *l.* to cover the duplicate pumps, and the whole of the lifting establishment, which I believe to be considerably in excess of what will be required.

665. And what do you suppose it will cost per ton to lift it?—It will take about 15 *l.* per horse-power per annum, and about 800 horse-power is the requisite amount, so that it would be about 12,000 *l.* a-year; that would be one thirty-fifth of a penny per ton for a lift of 24 feet.

666. You propose to do it upon a large scale, and no doubt to do it *pro rata,* at the cheapest rate?—Yes, certainly.

667. When you come to do it in detail for the farmers at each side, lifting a smaller quantity with smaller engines, and smaller plant, will it not cost something more?—We have contemplated that the farmers would do it for themselves;

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selves; but whoever does it, it will cost a little more; but even if my estimate is double, it will only be one-seventeenth of a penny.

668. Now, with regard to the embanking of those sands, which is the one you have reserved in your minor scheme?—The Maplin Sands; that is the south portion.

669. There are several streams, are there not, that would run necessarily into the sea through those sands?—There are.

670. You explained just now that you propose to arrange as to that by putting traps or catch-water drains?—By putting catch-water drains round the whole inclosure, and carrying them outside at the most convenient points.

671. Then you do not propose to run any of those streams through the embankment?—Not any open streams: I do not know what streams the noble Lord is referring to; there are some that are at present navigable channels, and there are three channels that are partly navigable; we should combine the three into one.

672. Then would you run that stream across your land?—I have not quite made up my mind whether I should take it across the land or divert it across the edge of the shore, and take it outside, but one of those channels would have to be left open, perhaps, although it is very unimportant navigation; it is only little Thames hoys and things of that sort that go down it.

673. (To Mr. *Hope.*) You state, do you not, that the International Financial Company have undertaken to advance money for this scheme?—No, they probably would do so, but the scheme is my own. The International Financial Society was only formed last year, and this is a scheme of Mr. Napier's and my own, which we projected before the formation of that company.

674. Then you have no certainty of receiving financial aid from any company, *quoad* the carrying out of the works independently of land improvement?—There is no reason to believe that the International Financial Society would not do it; if they place sufficient confidence in me to allow me to manage their affairs, they would, no doubt, adopt my scheme.

675. And would they find the capital for the scheme?—They would find capital, but we are prepared to proceed without them if necessary. However, I do not wish in any way to commit the society to the scheme.

676. Then, in your own mind, you appear to have arrived at something like a fixed sum which you consider to be the rent which you offer to the Metropolitan Board of Works?—It will be eventually realizable, it may be, in two years, or it may be in 10 years.

677. But you do not think that it will go beyond 10 years?—I should think that it ought to be realized in much less than that, in five or six years.

678. Do you make any distinct proposition to that effect to the Metropolitan Board of Works?—It is contained in this letter.

679. You have offered them half the profits, but did you give them any data on which to go as to what that would amount to, such as you have given to the Committee to-day?—It is in this letter, which is addressed to the Chairman of the Board of Works; and the amount estimated at page 15, as divisible between the Board of Works and the company, is 390,445 *l.* a year.

680. Do you think it probable that the International Financial Society would have sufficient confidence in your judgment to supply the means which you think necessary as based upon these calculations?—I think it a natural assumption to suppose that they will do so; however, that is no part of the scheme, and we are prepared, as I say, to proceed by ourselves.

681. Do you mean that you are prepared to proceed with an independent company?—With an independent company.

682. Are you prepared to go to the public without the aid of any financial company?—Certainly; we are prepared to do so without the aid of any financial company whatsoever. I may mention that we have expended a very considerable sum of money, upwards of 5,000 *l.*, upon the preparation of these plans and surveys.

683. Are you prepared to give anything in the shape of a material guarantee to the Board of Works, that you will be able to carry out your scheme?—I do not clearly understand of what nature a material guarantee could be.

684. Assuming that the Metropolitan Board of Works make you a concession of the sewage, are you prepared, by the payment of a sum of money, which you may call caution money, or by a deposit of some kind which you would forfeit if you did not carry out the works within a limited time, to pledge yourselves to their completion?—Certainly, if necessary; but we think that it would be very unreasonable on the part of the Board of Works to ask such a thing; and, accordingly, in 1862, when the Main Drainage Committee resolved to adopt our scheme, they did not ask for it; they asked for it in the first instance, but when I showed them that it was not necessary, they abandoned it. It would be necessary for us to deposit a sum of 70,000 *l.* before we could obtain a Bill, as Parliament requires us to make such a deposit, and it seems rather unreasonable to require us to make two deposits.

685. But the Parliamentary deposit, as you are aware, would only amount to a guarantee that you were going on with and meant to get your Bill, and after you had got your Bill you would be entitled to get back the Parliamentary deposit?—It is a direct forfeit, I believe.

686. (To Mr. *Hemans.*) Can you state whether that is so?—It would be necessary to give a bond to carry out the work, and the Treasury who take the deposit will let the money out on a bond for double the amount, on perfect security that the work will be carried out, and that amount will be forfeited if the work is not done.

687. What would the deposit amount to on these works?—The amount we held ready to deposit in 1862 was 74,000 *l.*, but with this reduced scheme it would be 64,000 *l.*

688. Mr. *Tite.*] Is that eight per cent. or ten per cent.?—It is four per cent. on works of this nature, and eight per cent. on railway works.

689. Lord *Fermoy* to Mr. *Hope.*] There were two clauses in the advertisement of the Board of Works on the 11th of May 1863, with regard to that material guarantee: "In any contract, provision must be made to secure to the Board the return of the sewage works, and the full power to relet and deal with the same, and so that the Board may, in case of any failure of the contractors or their operations, be left to their full rights, and without any cost to the Board." Were you prepared to agree to that condition?—Certainly.

690. The next clause in the advertisement says, "The tender must contain the names of two or

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or more sureties to be approved by the Board, who shall be jointly and severally bound in a competent sum, for the due performance of the contract, and for the efficient execution of the works in accordance with the provisions, and subject to the limitations of the Metropolitan Local Management and Main Drainage Acts." Were you prepared to agree to that?—Certainly; the best course I should say would be that we should lodge the Parliamentary deposit in the hands of the Metropolitan Board of Works, until it should be required by Parliament, and it might then be transferred as the Parliamentary deposit. It seems quite unnecessary that two separate deposits should be made; it would be a waste of money, because as soon as the Company is formed it would be the Company's money and not ours.

691. Did you comply with those two clauses when you put this tender in?—I was in Spain when that notice was issued and I am not prepared to state whether we did or not.

692. (To Mr. *Napier.*) Can you state that?—I think not; I think there was no statement made as to the sureties who would be offered as to the execution of the contract, but I think it was stated that we should be prepared to give the surety.

693. Did you give the sureties before the Main Drainage Committee's engineer reported in your favor?—There were no sureties I believe required at that time at all. The conditions made by the Metropolitan Board lately were different from those which they made previously; in the previous case there were no sureties asked for, but we offered to deposit a certain sum of money.

694. (To Mr. *Hope.*) Then did you comply with the requirements of the Board of Works on a former occasion?—We did everything on the former occasion that the Board of Works asked for and the Main Drainage Committee came to the following resolution: "That the Committee entertain very favourably the proposition for dealing with the sewage of the northern area of the Metropolis contained in the communications from the Honourable William Napier and William Hope, Esq., and recommend the Board to assent to the principle of a concession to the sewage, for a term of 50 years, provided the requisite authority be granted by the Legislature to the Board, and subject to the introduction of all necessary clauses in the Bill, for the protection of the Board, and of the public interests confided to them, and for ensuring the fulfiment by the Company of the obligations undertaken by them."

695. *Chairman.*] Had you complied with the conditions when the Main Drainage Committee reported in those words?—We had complied with everything.

696. Had you complied with those conditions which the Noble Lord the Member for Marylebone has alluded to?—Those conditions were not then in existence.

697. Lord *Fermoy.*] In point of fact, you never have complied with them?—We have never been asked.

698. Being confident, as you appear to be, that this scheme will return a profit of from 30 to 40 per cent., and that your own financial company or some other company would assist in finding the capital, or would find the capital, to carry out that scheme upon the receipt of one-half of the profit as a return to the shareholders, do you not think that you might go a step further and make a positive offer to the Board of Works of a fixed sum for the sewage?—I think it would be very undesirable to do so; it would increase the difficulty of obtaining the money, because there would be this fixed rental hanging over the heads of the shareholders, and you could not go to the outside of the value to be realised, you must leave a very wide margin indeed if you offer a fixed rental. Still, if the Metropolitan Board of Works have sufficient confidence in the scheme to adopt it, they would naturally have sufficient confidence to expect the realization of the figure which was held out to them as their share of the profits, and it is therefore their interest rather to take their chance of a less sum at first in the hope of obtaining a greater sum eventually.

699. Do I rightly understand you to state that the Board of Works have adopted your scheme?—No, they did adopt it, but now it is in abeyance. The Main Drainage Committee of the whole Board adopted it on the 10th of January 1862, by the resolution which I have read, but their decision has not been confirmed by the Board, and the decision of the Board has been postponed in consequence of the notice of motion of the Parliamentary Committee of 1862, which was given on the evening of the 6th of February, and the Board met the next morning.

700. Then the scheme has not been adopted by the Board?—No.

701. In order to induce the Board of Works as a condition to adopt your scheme, would it not be worth your while, and would it not be safe for you, if you are right in your premises, to make a positive offer to the Board of Works of a lesser fixed rent for the sewage?—It would certainly be quite safe, but I think it would not be desirable.

702. (To Mr. *Napier.*) Do you wish to add anything to that?—The public are against this kind of proposals.

703. *Chairman.*] Did you not state that you had withdrawn your scheme before the Board?—Only the financial part of it; we specifically left the proposals before the Board, but as we did not choose to have the financial conditions hanging over our heads for a certain time, we withdrew that part of the scheme, and stated that we should be ready to communicate fresh financial proposals, whenever the Board was ready to receive them.

704. Lord *Fermoy.*] But is not the financial part of the scheme the backbone of it?—Yes, but it was on condition that we got the concession within a certain date, and as we did not get the concession, we withdrew the scheme.

705. Is it before the Board now?—It is before the Board now in this letter.

706. It is before the Board again in a modified shape?—In a somewhat modified shape as to the extent of it.

707. Mr. *Tite* (To Mr. *Hope*)]. We understand then from you that the Board of Works have not adopted your scheme as a Board, though it was recommended by the Committee?—They postponed their decision for the report of the Parliamentary Committee.

708. Since that time, have they advertised again, and re-opened the whole question?—Yes.

709. Have you or your colleague, Mr. Napier, attended the Board recently with regard to any explanations that were necessary?—On the 23d of

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of February we attended a meeting of the Committee, not of the Board.

710. On the 23d of February you attended the Board of Works with Mr. Napier?—Yes, but unfortunately Mr. Hemans was unable to attend.

711. Was not a personal examination of your scheme in project, and proposals suggested to you?—Yes.

712. Did the Board of Works point out the necessity of this new arrangement with regard to caution money?—No, that was not touched upon at all.

713. Were you not questioned upon that?—Not in the least.

714. Is that the position of affairs at the present moment?—Quite so.

715. Were you asked at that meeting with regard to an annual payment to the Board of Works being made?—We were.

716. How does that stand?—They seemed rather to agree with us that it was undesirable, and that no body of shareholders would be willing to have a fixed rent under such circumstances hanging over their heads, and that they would prefer dividing the profits.

717. Is not that inconsistent with the principle on which railways are promoted, where people go into a speculation of that kind, relying on their own judgment?—Railways are not an experiment, and this to a certain degree, on so great a scale, may be considered an experiment.

718. You have not been asked that question, and you have not undertaken it?—No.

719. You are to raise all the money, and some company which has been formed since would assist you; is that so?—Very materially.

720. If the company would concede so much, why would they have any difficulty in conceding the further point of a fixed rent?—They would first of all wait until it was asked for.

721. You suggested the possibility of it, did you not?—I mean to say that they would first of all wait, before they offered a fixed rent, until the Board of Works expressed a wish to have a fixed rent.

722. But supposing that the Board of Works demanded a fixed rent, does the difficulty in that particular represent the same amount of difficulty that it did before?—I think that the directors would naturally agree with me that it would be very objectionable to place the scheme before the public in that shape; it would render the shares unpopular.

723. It would be objectionable as regards its results?—Quite so; it would evidently be impossible, supposing that a scheme were adopted (I fancy this is rather the tendency of the Honourable Member's question), which proved a failure, for the company to go on paying a heavy rental, and therefore it seems to me to be a matter of very little importance whether it was a fixed rent or not.

724. If there are two or three schemes, and the Board of Works pinned their faith on you, would they not have great difficulty in beginning again with anybody else?—That might be so.

725. (To Mr. *Hemans*.) Do you know the embankments in the North of Ireland, on Lough Swilly and Lough Foyle?—I know them very well.

726. They have been constructed by an Honourable Member of this House, have they not?—Yes, they have been constructed almost entirely by Mr. M'Cormick.

727. Is the extent of those works very great?—Yes.

728. What has been the result of those works, economically and commercially?—I know that exceedingly valuable property has been reclaimed, and land which was formerly mere sand and shells has been lately valued at 50 *l.* an acre.

729. Was that sand, or was it mud?—There was a good deal of sand within that area, but the surface that the crops are grown on is a deposit of mud upon the sand.

730. Is that value of 50 *l.* an acre the fee?—Yes.

731. That does not seem to suggest a profit of 40 *l.* an acre rent?—That 40 *l.* an acre is entirely due to the sewage. This land on the Maplin Sands without the sewage would not be worth a shilling an acre.

732. Are those levels in Lough Swilly and the Inch, which are embanked, producing crops at the present moment?—Beautiful crops.

733. Are they extensively cultivated?—They are extensively cultivated, and they are producing very fine crops.

734. *Chairman.*] Where are those places to which you are referring?—The two estuaries of Lough Foyle and Lough Swilly, and I may mention that the depth of sea-water at high tide upon those banks is considerably higher than it will be on this one.

735. Mr. *Tite.*] How many acres has Mr. M'Cormick embanked?—I think between 3,000 and 4,000 acres. He has seen these plans, and he was quite prepared to have given evidence as to the facility of taking in these lands.

736. Dr. *Brady.*] Do you propose using any steam power?—I do; I believe it will be necessary to perfect the drainage.

737. But in propelling the sewage through the culvert, do you propose to use steam power?—No.

738. Do you propose using any mains to convey the sewage?—If lateral lands are to be supplied, some short drains would be required to lead the sewage into the farms.

739. Have these lateral lines which you speak of been taken into consideration in the estimates?—Not in detail; there is a large margin left for contingencies of that nature, and of all kinds, and that has been the view that we have adopted.

740. (To Mr. *Hope.*) Do you wish to make any statement as to the financial part of that arrangement?—I may state that all the money which is necessary for the supply of the sewage to the farms on each side would equally be supplied by the Lands Improvement Company.

741. Is it the fact that three-fourths of the line cannot be supplied with the sewage without raising it by steam?—There would probably be a considerable area at some little distance from the culvert.

742. (To Mr. *Hemans.*) You have altered your original plan considerably; you do not propose making use of the Dengie flats now, do you?—It is now the intention to abandon the Dengie flats.

743. Did you not give it as one of the reasons why you do not use the Dengie flats, that some chemists had examined the ground, and that they thought it was too rich?—That was one of the reasons.

744. Could you inform the Committee who were

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were those chemists that examined it?—One of them was Professor Way.

745. Is it lately that that examination has taken place?—No; that occurred two years ago, when this project was first instituted.

746. Did Professor Way make any report upon this scheme?—He inspected the grounds in company with myself and other gentlemen, and I believe he made a report.

747. Have you any objection to place that report before this Committee?—I presume that there is no objection to do so, but I have not got it, nor do I recollect the details of it at this moment.

748. (To Mr. *Hope.*) Have you that report? —Professor Way gave us a written analysis of the mud, but the report was verbal.

749. But can you place before the Committee his written analysis of it, and his reasons, which of course will appear with the analysis?—I do not think that I have preserved the analysis; however, possibly, I may have a copy.

750. Professor Way reported for the direction of your company, and upon suggestions of his, I presume you left out the Dengie portion of the land in your scheme; is it not so?—Not wholly so; it was also upon the advice of practical farmers as to the great expense of levelling and preparing the Dengie flats for irrigation.

751. Then have you not kept a copy of Professor Way's report?—He made no report.

752. Have you not a copy of his analysis?—I may or may not have it; I really do not know, but it is a matter of no consequence, because his advice concurred with the advice of other gentlemen; the Dengie flats are no longer a portion of our scheme.

753. You state, do you not, that it is a portion of your plan to keep in the Company's possession a portion of this land?—It would all be in the Company's possession.

754. But do you not propose to keep a portion of it for the carrying out of dairy purposes, or grazing purposes?—To a certain extent; but of course, those details would be entirely in the hands of the Directors of the future Company, whom we cannot bind; we should make those suggestions to them in the formation of the Company, and there would be practical men upon it who would be much more competent than ourselves to manage those details.

755. You stated, in answer to a question put to you by an honourable Member, that you would propose to retain some portion of the land in your own possession?—It would be our suggestion to the Company not to let the whole of it off.

756. Supposing that you kept it in your own possession, would the Company form a dairy, or carry out dairy purposes?—No, our proposal would rather be that the Company should distribute the sewage over the land, and erect farm buildings and cattle sheds for the dairy farmers; that they should then let those farms as mere buildings, or perhaps give them gratis, in the first instance, to dairy farmers, and sell the produce to the farmers daily at so much a ton.

757. You have stated that the Edinburgh experiments were a great success?—Yes.

758. To whom have those experiments been a success?—To the proprietors.

759. They have not been a success to the ratepayers?—Certainly not; they get no benefit whatever from the arrangement.

760. Would you like the same principle to be carried out in this case?—Certainly, if the Board of Works would give it us for nothing; but I am afraid there is very little chance of that.

761. (To Mr. *Hemans.*) You stated that it was your intention to pump off a portion of the water of the sewage which was in excess?—Yes.

762. Although you are not a chemist, but an engineer, do you not know that the portion which you pump off contains the principal manurial properties of the sewage?—I think quite the contrary; I think that it ought to come off as pure water; the sand would act as a filter, and the water would come away pure, leaving the valuable property of the sewage behind.

763. The sand being very porous would permit a very large amount of manure to pass through it, and in passing through it, it would not have the capacity of retaining the manurial properties of the sewage, but it would leave on the top the indigested matter, as it were, which is not good for the land?—The crop would take up that; it would be absorbed by the crop. That is the result of the experiments which have been made.

764. (To Mr. *Hope.*) What is the amount of the deposit in the meadows near Edinburgh?—In 40 years, the deposit from a very large quantity of sewage on the Craigentinny meadows is half-an-inch of black deposit.

765. (To Mr. *Hemans.*)—You state that you give a fall of nine inches in a mile?—Yes.

766. Would that be sufficient?—It would deliver more than the 10 million cubic feet per diem.

767. Mr. *Hibbert.*] You state that you propose to lift the sewage at a distance of nine miles from the Abbey Mills; do you propose to lift it to a reservoir?—A reservoir may perhaps be acquired; it is not absolutely necessary, but I think it may be useful.

768. Would not that reservoir be a nuisance to the neighbourhood?—It would be covered. There is already a reservoir at Barking 10 acres in extent, which has been made by the Metropolitan Board of Works, but being all covered it is not expected that there will be any nuisance.

769. If there is no reservoir, how would you expect to distribute the sewage?—It would pour in a continuous stream along the culvert.

770. Are there no people living upon the open part of the culvert?—There is scarcely any habitation about there.

771. Are there not two villages upon one side? —Burnham would be near the commencement of it, but that is in the Dengie which is now given up; but if that had been carried out, on further consideration, I thought that it would have been desirable to put a roof over the reservoir; it might have been roofed in at a moderate rate, but that has been abandoned.

772. Of what shape and of what material do you propose to make the culvert?—The culvert will be very similar to those which have been constructed by the Board of Works for the northern outfall to Barking, that is to say, the base will be concrete, and then the culvert itself will be a brick arch with abutments, and an arch like the northern outfalls. It would be circular throughout, with a square foundation in the embankment, and in the cutting it would be entirely circular.

773. Do you consider that the embankment which you propose to make would be sufficiently firm and compact to keep out the sea at high water?—I do, for two or three reasons. In the first

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first place, high water is of temporary duration; it would run on a surface which has quarry chips below, and then is puddled; and secondly, we know, from the whole of the experience which has been obtained on that coast, and from all similar works, that the moment we shall have constructed in a straight line any part of that embankment, the deposit of the sea on the outside of it will make the sand higher there than it is on the inside, and consequently that would be a further layer of protection for preventing the sea from percolating through.

774. Do you propose to take the puddle below the level of the sand; would there be no danger of percolation underneath?—No, I think that that would be entirely unnecessary.

775. Are you aware that one of the rivers on the Marecombe Sands is continually changing its course, and that on that account it has endangered the embankment to which you have referred?—I am not aware that the embankment has sustained any danger, but quite the contrary. The River Severn did change its course every time almost till those works were constructed, but since that time it has remained stationary. I am in a position to state, from information which I have received from Mr. Brumbes, who constructed those works, that there has been no injury whatever to them since they have been constructed. There is a viaduct there which is placed on the sands supported by columns, and it is perfectly well supported by those sands.

776. Are you aware that they have been obliged to protect the base of that within the last two years?—It is quite possible that they may have been obliged to drop some stones along the foot of it, but that is a very unimportant matter.

777. How do you propose to put on the coat of Kentish rag?—It would be quarried on the Medway, and boated there, and then wheeled up by men.

778. But in what way would it be placed on the embankment; would it be merely laid on?—I have a section here, showing the core of sand; over that is the puddle, and over that a sloping wall of stones rather deeper than they are thick, and paved in a rough way.

779. Are you aware that the stones are paved in on the Morecambe embankment?—It is so. I have done it in that way for miles of sea-wall.

780. (To Mr. *Hope.*) Are you aware that nothing is paid for the sewage at Edinburgh?—I am perfectly aware of that; but that, of course, does not alter the agricultural result.

781. If the farmers were obliged to pay for the sewage, the land would not be worth so much per acre, would it?—Clearly not, but it would produce the same, and the agricultural profits would be the same.

782. But with regard to the value of the sewage to the town of Edinburgh, do they receive anything for it?—Nothing; the sewage flows into a natural stream, which happens to pass through this farm; and passing through the farm they have gradually adopted it for irrigation, and extended the system, as they found that it paid much better than ordinary cultivation.

783. How many tons of sewage do you propose to distribute on the Maplan Sands?—If the whole of the sewage is placed there, it would be about 8,000 tons per acre per annum.

784. Are you aware that the application of a large quantity is not so profitable as the application of a small quantity?—On the contrary; the experience of Lord Essex's Commission proves that the return of farm sewage is in direct proportion to the quantity which is applied.

785. But are you not aware that, according to the evidence given before the Committee on Sewage, the most profitable quantity applied was 500 tons or 600 tons per acre?—I do not think that there is any evidence to prove that; I think that the proof that there is no waste of sewage in large application is, that the additional return from the last 100 tons is the same as from the first; if there was waste, that would not be so.

786. Supposing, that on experience, the farmers prove that the application of a small quantity is quite as profitable as the application of a larger one, and might object to take 8,000 tons or 9,000 tons per acre, what would you then do with it?—They could not possibly object if we applied the sewage to the Maplin Sands; that is the advantage of our scheme. We should be able to take the sewage there all the year, notwithstanding any objection from the farmers; but at Edinburgh it is not the case that they object; the farmers there take the ground by acres and half acres, and they quarrel with the watermen as to the amount which is put on; but they always want more, not less.

787. Are you aware that nothing is paid for the Rugby sewage?—I am not aware; but for many reasons that is no practical experiment as to agricultural requirements, because great expense has been gone to, and the whole of the sewage is pumped, whereas in this case it would all flow over the ground.

788. Are not the returns at Rugby satisfactory?—Certainly not, except as experiments.

789. (To Mr. *Hemans.*) You stated, did you not, that the distribution is to be by open gutters? Yes.

790. Does that refer to the Maplin Sands, or to the land, or the side of the culvert?—To the Maplin Sands.

791. Doctor *Brady.*] Is it not the fact that storms generally come on at high-water tide?—I am not exactly aware of that; as a physical fact, I think, that in the open sea storms are quite independent of the tide.

792. But is it not so with regard to storms on the coast, as affecting this wall?—It is not in my knowledge.

793. (To Mr. *Hope.*) Are you aware that that is the case?—I do not think that it can be the case, because when there is a storm on this coast, there is one on the coast of Holland; and when it is high-water on one side of the channel, it is low-water on the other.

794. Mr. *Caird.*] You propose to grow grass yourselves, and to sell it to the cow-feeders; so that the difficulty could not arise of the farmers refusing to take the water?—No; there would be no such difficulty.

795. Have you not found any land which is suitable for the application of this sewage nearer London than at a distance of 44 miles?—We consider that it is very desirable to take the sewage as far from London as possible, in order to prevent the possibility of any nuisance arising from it; and by going to the coast of Essex we, in the first place, get land very cheaply; and, secondly, we get land which is not useful for any other description of crop, and which is therefore not wasted by the application of the sewage.

796. The further you go the more you increase the cost of carrying the sewage, and also the cost of

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of bringing back the produce if you look to London as your market; is not that so?—There is a railway to Southend, and we propose to continue a steam tramway from the railway.

797. Do you propose to continue a tramway from the railway to your own ground?—Yes.

798. What is the nature of the country through which your culvert passes, from the place at which you pump the sewage to these sands, is it a hilly country?—For the first 10 or 15 miles, I suppose it is an undulating country of clay and chalk.

799. (To Mr. *Hemans.*) What is the nature of the country nearer the line of railway to Southend, and not at such a distance as this line is laid down at; supposing you had followed more nearly the line of railway than you have done, would you have got a country suitable for the carrying of the culvert all the way?—I could have got a level line of country from the sea to Southend, and except with regard to the necessity of going to Dengie with much better lines, and I am going to advise the promoters of the scheme when they go to Parliament to alter the levels, and not to cross the Crouch but to go farther inland.

800. With regard to your produce would it not be very important to have it nearer a line of railway?—I stated that in going to Parliament afresh, with a fresh deposit of plans, not having occasion to go so far north up to Dengie, I should not make the crook go in the direction which I at first contemplated.

801. *Chairman.*] Would you go through Prittlewell and Wakering?—Yes; to bring it in towards Wakering.

802. Mr. *Caird.*] But between Barking and Stamford-le-Hope, would there not be a suitable country through which to carry your culvert nearer the line of railway?—The length of it would be greatly increased.

803. Would not that give you an increased surface over which to apply the sewage?—Yes; that would give an increased surface of lowlands, but the length of the culvert would be increased considerably.

804. In a commercial point of view, you do not think that would be an advantage to you?—I think not.

805. (To Mr. *Hope.*) What is your opinion upon that point?—I may state, that we never contemplated exporting the green produce; we contemplate bringing the cowfeeders to consume the produce on the spot.

806. And you propose sending it up to London in the most concentrated form?—Yes.

807. (To Mr. *Hemans.*) Have you made any inquiry as to any ground nearer to London than these sands?—I think it is impossible to find any ground suitable for the purpose nearer to London.

808. Have you considered whether any of those marshes on the Thames would be available?—I have considered that, but, in the first place, it would be difficult to get hold of them, and secondly, I think that they are less suited than the sand is for the application of the sewage.

809. Have you made any calculation as to the cost per mile of carrying the sewage in a liquid form which is pumped by your culvert?—No, I cannot say that I have taken it in that way, but it might be arrived at by taking the cost of the culvert and dividing it by 100,000,000 tons.

810. Can you state what is the cost of the carriage of the sewage, by your system, per ton for the whole distance?—Taking 100,000,000 tons it is 0·17 of a penny per ton, that is the cost of conveyance.

811. If we add to that the expense of pumping, what would the sewage cost you delivered on those sands independently of any sum that you may pay to the Board of Works?—It would be about three times that amount.

812. Having a long line of this kind for your main culvert, would not that give you a larger surface over which to apply the water in case in the gradual progress of time, and the increase of the city, a larger quantity of sewage were to be disposed of?—I do not anticipate that at all.

813. Do you not look at that as a matter of importance in your scheme?—I look to the 8,000 tons per acre which we can now deliver on the Maplin Sands, which hereafter may be too much for 12,000 acres, and therefore the more we can distribute on the way the better. The longer the distance the greater will be the area for the distribution.

814. (To Mr. *Hope.*) Does your scheme rest upon a probable return of 40 *l.* an acre?—No, it is not in the least necessary that we should obtain 40 *l.* an acre to pay the expenses, nor even to pay something to the Board of Works; the half of that is more than sufficient.

815. Do you take 40 *l.* an acre as the highest return from the meadows in the neighbourhood of Edinburgh, the cost of carrying the sewage, and the cost of bringing back its produce being there, as you are aware, almost at a minimum from the proximity of the place to the City?—I do not think that the cost of carrying the produce is at all at a minimum, because there is green produce actually carted away, which is a very considerable expense, whereas we propose to bring the cows to the spot, and export the manufactured article of milk.

816. But do you still hold that on a much more moderate estimate of the produce, you could give a good interest to your shareholders?—Certainly.

817. Taking it at 20 *l.* an acre, would that be the case?—That would give 10 per cent. to the shareholders.

818. And would it also give 10 per cent. to the Metropolitan Board of Works?—Yes.

819. That would give 20 per cent. altogether, would it not?—Yes.

820. Then, even if you only got one-half of the sum which is estimated in this paper, that would pay 20 per cent.?—That would pay 10 per cent. to the Board of Works, and 10 per cent. to the company.

821. Is that 10 per cent on the share capital, exclusive of the debentures and of the rentcharge?—Yes.

822. Would that leave the sewage on the south side of the metropolis still for sale?—Certainly.

823. Would that remain for a separate revenue altogether?—That would remain for a separate revenue altogether.

824. With regard to the impurities of rivers, are you aware whether any of the sewage which you are likely to receive, contains matters noxious to vegetation?—The general opinion is, that that would not be the case at all, but it might prove that certain manufactories supplied such noxious elements, and I presume that the Board of Works would take measures to divert that stuff from those factories, so that it should not produce any injurious effect.

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825. It has been stated that the value of the sewage has been computed at 6 *s.* per head of the population, upon what estimate is that calculation formed?—I believe that that is based upon a very long series of experiments by a number of different chemists, but that is only the theoretical value.

826. Has that any reference to the expense of carrying the sewage from the place at which it is thrown into the river to the place of its application?—None whatever.

827. Then the cost of that has to be added to the 6 *s.* referred to, has it not?—Quite so. Professor Way, in his evidence before the Select Committee of the House of Lords on Town Sewage, put it very clearly, I think, in his answer to Question 774; he says, "If you gave me dried sewage it would be capital manure for any crops, no matter whether wheat, or green crops, or grass; it is merely the form in which you present it, that makes it unsuitable for some crops. It strikes me that it is the same kind of thing as if a man were to owe me the value of an ounce of gold, and were to bring it to me in the shape of gold quartz, saying, 'Here is so much gold quartz, which contains 4 *l.* 15 *s.* worth of gold,' or whatever it may be; that would not be paying me at all, I should have to take it with all its disadvantages, and to get it out of the quartz."

828. Sir *Joseph Paxton* (to Mr. *Hemans*).] How many miles of open culvert have you?—About 15.

829. Is that in the main?—There were two branches as it originally stood, but as it will be altered now there would probably be none, a plan has been deposited upon which I have been giving evidence, and I am obliged to give evidence now on an altered plan which has not been thoroughly detailed, but by taking the culvert to Shoebury Point, I believe I should be able to keep it covered throughout.

830. You are aware, are you not, that taking sewage in an open culvert deteriorates its value very much for agricultural purposes?—I think it would depend very much on the rate of delivery and the length of time during which it would be exposed.

831. On 15 miles would there not be a very large loss?—I am not quite aware as to that; I have no specific information as to the amount of loss, but I think that we may dismiss that subject as one of no great importance, because the open channels are to be abandoned.

832. Are you not aware that when the sewage goes into a river after it has passed 10 or 15 miles it becomes pretty clear again?—Yes; but that is a different thing; that is partly from filtration and partly from evaporation, that would be so, no doubt.

833. (To Mr. *Hope.*) What is your opinion upon that point?—I recollect the same question being put to one of the scientific witnesses before the last Committee; he was asked whether there would be much loss, and he stated that where there was much smell there would not necessarily be any real loss, and he instanced a grain of musk, which might remain in a room for many years, giving a strong odour all the time, and yet at the end of that time the piece of musk would still weigh a grain.

834. You have been asked whether you would offer to the Board of Works a given sum for this sewage, do you decline to do that?—I decline to do that.

835. Your capital is 1,600,000 *l.*, of which 1,100,000 *l.* is to be raised by shares and 500,000 *l.* by debentures, is that so?—Yes.

836. After the debentures are paid, and you have the net earnings to divide between the Board of Works and the shareholders, would you have any objection to give them a preference of 50,000 *l.*, for instance, a year before any other divisions took place among the shareholders?—I think that it ought to be quite the other way, and that the preference ought to be given to the shareholders who are spending the money.

837. But are not the Metropolitan Board of Works there asking for some guaranteed income for the use of this sewage which they possess?—No, they have not asked for it; they seem to concur with me in the opinion that it would be undesirable to give it, and that it would be better to take a portion of the results whatever the results might be.

838. But supposing you have all the confidence in the scheme which you have stated to this Committee that you feel, would you have any objection to that?—It would be very difficult to inspire several thousands of shareholders with the same belief.

839. In fact, do you think that you would not impress the shareholders sufficiently strongly with your scheme, as to induce them to offer a preference of 50,000 *l.* or 25,000 *l.*, or in fact anything?—I think, from my experience, that it would be quite impossible to pursuade any body of shareholders to give a rent for property of any nature, especially for any new material of any nature with which they are unacquainted, and on which no great experience had ever been gained.

840. Mr. *Tite.*] Do I rightly understand you to state that at the meeting of the 24th of February, where that question was distinctly raised, you received the impression from that Committee which was a large and open Committee, that they were willing to adopt the principle of taking their chance with you, and taking what they would get out of it, or the reverse?—I certainly received the impression that they were willing to take their chance with us.

841. And did you leave that meeting without being asked to consider that question?—Distinctly. With regard to the question which was put to me by the honourable Member for Coventry, I did not understand whether his meaning was that the preference was to be paid first.

842. Sir *Joseph Paxton.*] After the bonds were paid the first proceeds, so far as the share capital is concerned, by your lowest estimate will be 20 per cent., and that would be 5 per cent. upon the 1,000,000 *l.*?—Yes, if the Board of Works would guarantee 5 per cent., they could do the whole thing themselves without the company, but if they call in the assistance of the company, they must naturally pay for it.

843. They have an article to sell, and they must make the most of it?—Yes, but the amount that they have to sell is so large, that no private individual could undertake to purchase it, and they must appeal to a company.

844. Supposing that other parties came before the Board of Works, and offered the sort of terms that I have described, do you think they would be wise to accept those terms rather than yours?—I think that it would be of no use to make the offer, because it could not be carried out; money could not be obtained in the City on those terms; no one would subscribe.

845. That is entirely a matter of opinion, is it not?

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not?—No doubt, but I think that you would find that the Stock Exchange, who generally have to do with those matters, would be very unwilling to risk a penny with such a thing hanging over their heads.

846. In fact you have not sufficient confidence in the scheme?—I have confidence in the scheme, but the public would not have it, and the sums named would be only one-third, or one-fourth, of what the Board of Works would eventually get.

847. They might get it, but would not it be better for the shareholders if they had a conviction that they would get 20 per cent. or 40 per cent. themselves, to offer to insure 15 per cent. to the Board of Works?—I should think that it would be very doubtful whether the Board of Works would agree to so small a payment as 20,000 *l.* a year, as the Honourable Member suggested just now.

848. Mr. *Bright.*] What is your estimate as to the time that would be required to complete the whole of those works, and to have the question of the sewage on the north side of the Thames settled?—Three years.

849. Would that afford a sufficient time for the experiment, so that the sewage on the south side of the Thames might be dealt with safely on your experience, either taking your plan or avoiding it, as the case might turn out?—Yes, I think so; probably they would allow three years for the completion of the works.

850. Would four years be sufficient?—Yes.

851. With regard to the question of paying a certain sum to the Board of Works, is it not a fatal objection to such a scheme, that your company would be a company formed upon the principle of limited liability, and that if it did not succeed your funds might come to an end, and nobody could be called upon to pay?—Quite so; I do not see really how any company could make a bargain of that nature; if the scheme were not to prove a good one, they could not possibly fulfil the engagement.

852. If the concern should be profitable to your company, would it not be a great advantage to the Board of Works to get rid of the sewage of this City?—I should think so.

853. And might not that be an advantage which might fairly induce them to take whatever risk you take, they finding none of the capital?—I should think that would be a most ample inducement; they are threatened with a prosecution at Barking under their Act of the 2d of August 1858.

854. Do you mean at the present time?—I believe so; that is under clause 31 of the Act.

855. Sir *William Russell.*] Did you state, that you and Mr. Napier originally settled the scheme, and that you proposed to form a company for the purpose of taking up this matter yourself; that since that you have hoped to obtain the capital from the International Financial Society, and that the reason of your reducing the amount of your capital, is that the Land Securities Company, or others, would find all the capital on the ordinary rate of six per cent. over 22 years, for the purposes of putting up the buildings as they would advance it to any other landowners in any part of England?—Yes, quite so; and for the preparation of the ground.

856. Would they also be able to find the money at the same rate, and for the same purposes, in the district over which, as I understand Mr. Hemans, one-fourth of the culvert is above ground?—Yes.

857. Would it be possible for the Land Securities Company to find the necessary money for the farmers who wished to use it for the purpose of levelling the ground, and making those channels which would be requisite for carrying the sewage on to their lands?—The whole of the money would be supplied in the same way.

858. That would be advanced to the landowners owning that property, and would not be a charge against your company?—That would not be a charge against the company.

859. And if the sewage were required afterwards over the three-fourths of the district where the tunnels are at present under ground, and it became necessary to have pumping stations built, would it not be equally possible for the Land Securities Company, under their present Act, to furnish capital to the landowners to irrigate that land without any cost to your company at all?—Without any cost to the company; and I may mention that, by driving small tunnels into the sewer, you could irrigate and command by gravitation alone land which lies at some distance without any pumping.

860. Mr. Hemans states that the area which could be irrigated by the one-fourth of the tunnel which is above ground, would be about 30,000 acres, how much could be irrigated by the other three-fourths with the use of the extra pump, would it be 100,000 acres?—It would be a larger acreage, probably, than we could possibly supply.

861. You stated that, taking the land to pay only 20 *l.*, instead of 40 *l.*, an acre, the rate to the company would be 10 per cent?—Ten per cent. to the company, and 10 per cent. to the Board of Works.

862. That would produce 200,000 *l.*; 100,000 *l.* being the 10 per cent. on the capital of the shareholders, and the other 100,000 *l.* going to the Metropolitan Board of Works?—It would be 240,000 *l.*

863. Is that supposing it only let for 20 *l.* an acre?—Yes.

864. Then, as to the fixed rent, is it not the fact that at the present time, in Edinburgh, the town authorities are willing to give the sewage for nothing, for the sake of getting rid of it?—They would require to divert it from its present channel before they could get possession of it; it runs into a natural stream which passes through the farm, and they could only regain possession of it by intercepting that stream.

865. At present they do not charge for it, and are thankful to get rid of it, are they not?—Yes, I believe that is the case.

866. Therefore even if the Metropolitan Board got nothing for the sewage, they would have the advantage of getting rid of it without having to find the capital for doing it?—Just so.

867. Did not I understand you to state that the deposit would be four per cent., and not eight per cent.?—Yes.

868. Would that come to 74,000 *l.*?—That was the sum that we had ready on a former occasion, but now it would be 64,000 *l.*

869. Would you be prepared to put that sum into the hands of the Metropolitan Board as a forfeiture, in case of failure of the success of your scheme?—Yes.

870. And are you also prepared to agree to that clause, that you would return the sewage works

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works to the Metropolitan Board of Works?—Certainly.

871. That was stated on the last day of the meeting of the Committee, was it not?—Certainly, the works would not be of any use to the company if the scheme was a failure.

872. Are you perfectly satisfied, that even supposing the farmers did not take any of the sewage over their land, you have sufficient area to consume the whole of it on the 12,000 acres?—Undoubtedly.

873. And is it not the fact that at Croydon, and at Rugby, and other places they find that the area that they originally took was a good deal too large?—Yes, and that was the case also with regard to the area which Lord Essex took on his own private property; he took 400 acres, and he said that 50 or 60 acres would have been amply sufficient.

874. With regard to Rugby; in consequence of the expense of pumping, it does not pay?—I believe that, as a practical experiment, it is a total failure; it is merely valuable as a scientific experiment, for which purpose alone it is undertaken.

875. Is it not the fact that at Croydon they do it simply by letting the sewage run from tanks straight on to the land, and that the land is improved enormously by that?—I believe that is so.

876. And therefore that tends to prove that irrigation by gravitation is the only method that will pay at all?—Yes; and I think that the risk of nuisance by squirting the sewage through a hose and jet would be much greater than by sending it over the land.

877. Is it not carried on at Glasgow by irrigation with pipes through the air?—It was carried on by that means; but that was not sewage—that was liquid manure.

878. Would not the land all require to be levelled?—It is so exceedingly level that only a minimum amount of labour would be necessary.

879. As to the unhealthiness of the land in the immediate neighbourhood of those works, is it not the fact that it is found that the neighbourhood of those meadows in Edinburgh is exceedingly healthy?—The principal waterman has lived in the centre of those fields for a period of 20 years, and he has not had a day's illness.

880. And are there not barracks in the middle of it, which are also very healthy?—I believe there are. At the same time the system followed at Edinburgh is very clumsy; the sewage, to begin with, is in a very different state from what the London sewage is, in consequence of the London sewage flowing through so many miles of pipes and conduits of every description it is completely churned up, and the solid matter in suspension is reduced to the smallest possible amount; but at Edinburgh the irrigating channels are simply rough ditches dug by hand in the soil with ragged edges; and as the Edinburgh sewage is full of solid matter of every description, the solid matter sticks in the edges of the channels, and when they are dry it creates a horrible nuisance. But in this case we propose to have tiles with a double lip, and with perfectly smooth edges in which nothing would stick, and one man walking down with a broom would sweep them perfectly clean.

881. A question was put to you with regard to the expense of farming it; if you kept the land in your own hands, would there be any expense with regard to that?—The only expense would be the watermen; we estimate that there would be from 100 to 120 watermen to clean the sluices, and so on.

882. Mr *Sclater Booth.*] As to the subject which the Honourable Member for Coventry was alluding to about your financial proposal, has not this subject been before the public for a good many years now?—Yes.

883. Are you aware whether any other individuals have offered such good terms as you have to the Metropolitan Board of Works?—Every possible description of offer has been made; I think that some have gone as high as 3,000,000 *l.* sterling per annum, but I think that there is no probability of any company agreeing to pay that as a minimum rent.

884. Dr. *Brady.*] Who made those offers?—I am not prepared to say.

885. Mr. *Sclater Booth.*] From the information which is before the Committee, it would appear that most of the proposals which were made the year before last were for a peppercorn rent for the first few years, was that so?—Yes; they varied from the first five years to the first 14 years, but I have not had time thoroughly to investigate the whole of the other schemes; I have merely read through them.

886. Although the Metropolitan Board of Works have had this valuable property for a good many years, nobody yet, except yourselves, has made them an offer which they are willing to accept?—Nobody, except ourselves.

887. So far as you are aware, is there any complete scheme in existence besides your own, which is prepared to be carried immediately into effect?—I am not prepared to speak as to that, but I believe not.

888. Supposing that you made an agreement with the Board of Works, you would, I presume, deposit your plans before next Christmas and immediately begin the works?—Certainly.

889. It is objected that you take the sewage a great distance from town, namely 40 miles, is it not a considerable element in your calculations that you get your land for nothing and pay no rent for it?—Yes, we merely have the charge on the money which is necessary to reclaim the land.

890. Without going into the subject at all scientifically, is it not the fact that a deep sand would be a very fit material for the filtration of this enormous mass of sewage?—Yes.

891. It has been stated that when you pour this diluted sewage on ordinary ground, the greater part of the valuable matter escapes through the draining tiles which would be two or three feet below the surface, whereas, in this great bed of sand it might fairly be presumed that a much greater proportion of the feculent matter would be taken up by the sand than would be the case if it were passed over meadows, the soil of which was clay with, perhaps, a subsoil of rock or other hard material which would not absorb such a great quantity; is that so?—Yes, I think that if the sewage is applied to grass to which alone it is capable of being applied in large quantities, the grass absorbs the whole of the manurial properties of the sewage in solution as well as in suspension, and the proof of that is that in the Edinburgh meadows, after a heavy crop has been cut, the roots of the grass are perfectly white from the want of air and light, and that when the first dressing of sewage is put upon

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upon them, they become a dark green in 12 hours.

892. What is the nature of the soil in the meadows at Edinburgh?—On the part which is analogous to the Maplin Sands, I think there is nothing below the sand at all.

893. Was it originally a bare sand?—I believe it was originally a bare sand blown about by the wind, and constantly shifting.

894. With regard to the pollution of the river, might it not be a possible argument in favour of your scheme, that the water which escaped after having been placed on the surface of the ground would go off purer, if it went at all, than it would if it were poured over mould or clay or any other soil of that character?—I think if you take the soil itself with no crop upon it, clay would be the best, if you were to irrigate fallow land, but where you irrigate crops the looser the soil is the better, because the roots can spread themselves down, and are more capable of drawing up the moisture.

895. Mr. *F. North.*] With reference to the Maplin Sands, has your attention been drawn to the fact that under any circumstances they would be saturated with sea water?—No; I think that will not be so.

896. How is that?—At first, of course they would be saturated with sea water, but we shall wash them by means of the sewage, and we shall keep the level of the water by catch-water drains, that is to say, the filtered sewage three feet below the surface, and of course no salt water can rise above that.

897. But will not the salt water come in underneath the wall which Mr. Hemans is going to construct?—No; I do not think that will be the case.

898. Mr. *Ferrand.*] What is the depth of the sand that will not be affected by the salt water?—I am not prepared to say, but I presume that it will be a very great depth. Mr. Hemans has made borings to the depth of 10 and 15 feet, and has found the same quality of sand throughout.

899. (To Mr. *Hemans.*) To what depth do you expect the tillage to sink?—To the depth of the top of the water in the ditches; we shall regulate that, it may be two, or three, or four, according to the level of the water in the ditches.

900. (To Mr. *Hope.*) How far according to your calculation will the tillage, which is the virtue of the sewage, sink down on to this land; will not whatever tillage is laid upon it sink far more rapidly, and far deeper, than it does on a stiff clay soil?—I think it would not sink at all; it would be absorbed by the soil on the surface; the crop growing on the surface absorbes the sewage, and the water that runs away is pure.

901. But to what depth will the tillage sink?—Two or three inches.

902. Then do you imagine that when you deliver the sewage on to the sand, the fructifying power will not sink lower than two or three inches?—When there is a crop on the top of the sand, that crop will absorb the fructifying properties.

903. *Chairman.*] Are you aware that in the report on the Metropolitan Drainage they state that even if the sewage is discharged into the sea at the River Crouch, it will hang about the coasts?—I have not seen that report.

904. You propose to let the outfall into the Thames; do you not?—The storm outfall, the filtered sewage from our land, would be let out through various valves as pure water.

905. Where would you let out the storm overflow?—We do not touch the storm overflow; that is let out by an existing provision made by the Board of Works.

906. Do you take only 10,000,000 cubic feet a day?—That is all that they can give us.

907. Mr. Bazalgette stated in his evidence, on the last day of the meeting of the Committee, that the dry weather sewage of the north side of the Metropolis alone amounted to 87,000,000 gallons per diem, and that that amounts to 168,000,000 tons in the year; was he correct in making that statement?—If he said that there would be 168,000,000 tons per annum from the northern side alone of the dry weather sewage, I really do not know whether he would be correct or not; but that would not agree with the statement which he made to us.

908. Do you take as much as that?—We take all that he is prepared to give us.

909. (To Mr. *Hemans.*) Do you propose to let the sewage on each side of the culvert run in open gutters, or through pipes, over the 30,000 acres?—That would all be matter of further arrangement, which is not thoroughly detailed as yet; but my idea is that, wherever a farm has to be accommodated, we should put a stop-cock, and that there should be an open sewer, or a covered trunk, according to the farmers' arrangements. With regard to the number of cubic feet, every cubic foot is about equal to 6¼ gallons, so that if you multiply the number of cubic feet by 6¼, you will get 60,250,000 gallons, and that nearly makes up the difference, but Mr. Bazalgette must include the storm water too.

910. (To Mr. *Hope.*) Is it not the case that the sewage flows through the sand at Craigentinny out into the sea?—The irrigation at Craigentinny is carried on in a very imperfect way, as compared with the way in which it ought to be done; a great portion of the sewage flows over the land; we do not propose to allow any to flow over the land, but merely to put it on in sufficient quantities, and to allow it to sink into the sand below.

911. Dr. *Brady.*] Are you not aware that land possesses only a certain capacity of absorption?—That depends entirely upon the quality of the land.

912. Are you not aware that, whatever land it may be, it has only a certain power of absorption?—I presume that that must be the case.

913. Then, supposing that you apply a larger quantity of sewage or fluid to land than what it is capable of taking up, must not the excess pass away?—It is a question of whether the land is fallow, or whether there is a crop growing upon it.

914. You stated to the Committee, did you not, in answer to a question put to you by an honourable Member, that the sewage, or the fertilising matter, sank two feet deep into the earth?—No, I said two inches; the filtered water sinks two or three feet.

915. Do you mean to say that if you put a large quantity of fluid on sandy land, that sandy land will take up the nutriment, and allow pure water to pass away?—No, that is not my theory at all; I say that the crop will retain it, and not the land.

916. But if the crop has a sufficient quantity before, what will become of the surplus?—Then we should give the crop no more dressing; we should

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should give it at a time only as much as it could absorb.

917. You have only a circumscribed place to put your sewage on, and you must either put it into the sea, or apply it to your lands. Is it not a well-known fact that sewage will pass through sandy land, and that a very large portion of the fertilising matter will pass away also?—If there is no crop upon it, that will be the case; but if there is a luxuriant and thick crop of grass growing on the surface, if the dressing is not excessive, the crop will consume the whole of the manurial dressing.

918. That is to say, if you placed just as much as the land would require, and no more?—And not more.

919. Sir *Joseph Paxton.*] Do you intend to pass this sewage over the 12,000 acres continually, or to apply it to each crop as each crop requires it; in the summer time would you have sufficient for that?—No doubt we could utilise a very much greater quantity.

920. In the winter you would let it pass over a greater part of the area, would you not?—Yes; in order to keep it as thin as possible on the surface, so as to get the double advantage of using the sewage, and of not allowing any of the fertilising matter to be lost, and so as to keep the roots warm for the early spring crops; by judicious management, six or seven crops can be got in the season; six can be got with ease, and seven in a good season.

921. Mr. *Tite.*] But if, from the state of the weather, it was not necessary for you to pour the sewage on to the land, you need not take it from Barking, but you may let the Metropolitan Board of Works deal with it as they should think fit?—We should propose to take it always.

922. Might not that follow if there was any difficulty about it?—We propose to bind ourselves to take it.

923. Mr. *Ferrand.*] Did you not state that you would apply the sewage in dry weather to the land?—No; we apply the dry-weather sewage, but not in dry weather only; we apply the sewage in all weathers; we take the ordinary discharge, which is all that the Board of Works can give us, because the Board have made a separate provision for the storm overflow, which never comes to Barking at all.

924. Mr. *Caird.*] (To Mr. *Hemans.*) Have you computed carefully the cost of lifting and conveying the sewage from the outfall at London to the place of its application?—Yes.

925. And what do you find it to be?—One-fifth of a penny per ton.

Lunæ, 23° *die Maii*, 1864.

MEMBERS PRESENT:

Mr. Sclater-Booth.
Dr. Brady.
Mr. Caird.
Lord Fermoy.
Mr. Leader.
Lord Robert Montagu.
Mr. North.
Sir Joseph Paxton.
Sir William Russell.
Sir Frederick Smith.
Mr. Tite.
Mr. Walpole.

LORD ROBERT MONTAGU, IN THE CHAIR.

GEORGE HOPKINS, Esq., called in; and Examined.

G. Hopkins, Esq.

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926. *Chairman.*] You are a Civil Engineer, are you not?—Yes, I am.

927. In 1845, you worked for Mr. Brunel, and continued to do so at intervals until his death?—Yes, I was with him for some years.

928. And you have been engaged in water-works, sewage-works, gas-works, and other engineering works, have you not?—Yes, I have.

929. In 1862, were you employed by Mr. Finch to examine this proposal of Messrs. Napier and Hope?—I was employed by Mr. Finch to examine the scheme of the "Metropolis Sewage and Essex Reclamation Company."

930. Messrs. Napier and Hope are the promoters of that, are they not?—They are.

931. That was the scheme which was examined into by the Committee at our last meeting, was it not?—Yes.

932. Is Mr. Finch the owner of Foulness Island?—Yes; he is the owner of the greater portion of it, of more than two-thirds, I think.

933. Did he consider that his property would be injured by Messrs. Napier and Hope's scheme?—Yes, he did; he had a great objection to it.

934. How was it proposed to take the sewage through his estate?—It was proposed to carry the sewage across his estate in an open culvert, elevated about 15 feet above the level of the island.

935. Would not that be objectionable?—He considered it exceedingly objectionable, and he was afraid that a very great nuisance would be created by it.

936. Did you go down to Foulness to examine the spot yourself?—I did; I was instructed by his solicitor, Mr. Bramwell; and I was down at Foulness, and in the neighbourhood nearly a week.

937. You examined into the present embankment walls, and into the site of the proposed embankment, did you not?—Yes; I made a thorough investigation. I examined the site of the proposed works, and the whole of Foulness Island, the river Crouch, and all the surrounding district.

938. Did you make all the necessary enquiries yourself?—As to everything that occurred to me, I did.

939. Were you assisted by anybody in making those enquiries?—I had the assistance of Mr. Wood, of Langford Hall, who is Mr. Finch's land steward, and has had the charge of his Foulness estates for a great many years. Mr. Finch himself lives in Rutland.

940. And did you examine the plans deposited in the Private Bill Office by Messrs. Napier and Hope?—Yes, I did; it was part of my instructions to examine them, and I had copies made of such portions of them as I required.

941. What opinion did you form of this scheme?—I was obliged to come to an adverse opinion. The scheme seemed to me to be beset with very great difficulties, and I reported to that effect.

942. Did you make a report on that subject?—I did; I reported to Mr. Bramwell.

943. What was the date of that report?—The 5th of February 1862.

944. Is that the report which has been printed by the Metropolitan Board of Works?—Yes, it was read at the Metropolitan Board, and ordered by them to be printed, and referred to the Main Drainage Committee.

945. Under what circumstances did you make the report; was it before or after the meeting of the Metropolitan Board of Works on the 7th of February that you sent it to them?—It was before the meeting on the 7th of February. The proposition of Messrs. Napier and Hope had been before the Board previously to the 7th of February, and it was to be reconsidered on that day.

946. Had the concession then been granted?—No, it was in abeyance at that time.

947. Was the concession ever granted?—No, it has never been granted.

948. There was a Bill in the year 1852 to do something of the same nature, was there not?—There was an Act in 1852 for reclaiming those sands, but it was not proposed to put any sewage on them.

949. Was that also opposed by Mr. Finch?—Yes, he opposed it. He had great objections to it.

950. Are you aware that Messrs. Napier and Hope withdrew their application for the sewage of the metropolis?—They did somewhere about that time. I am not quite sure whether it was before or after my report was presented; I think

it was after; but, inasmuch as they had failed to comply with the Standing Orders of the House, by paying the deposit of four per cent. on the amount of the estimate, the scheme fell to the ground, and soon after that they withdrew their application for the concession.

951. Mr. Hemans, their engineer, wrote a reply to your report, which has also been handed in to the Committee; that reply is dated the 13th of February; can you state to the Committee whether they withdrew their application before or after that reply of Mr. Hemans?—Yes, the application was certainly withdrawn before that reply was sent in.

952. Was it before the reply was printed, at all events?—Undoubtedly.

953. The Board ordered that reply to be printed, did they not?—Yes, it was ordered by the Board to be printed, and the letter is dated the 13th of February 1862.

954. Were you instructed by Mr. Finch's legal adviser, Mr. Bramwell, to write a reply to Mr. Hemans' letter?—Yes, Mr. Bramwell sent me a copy of Mr. Hemans' letter, with instructions that I should turn my attention to it, and write a reply.

955. What was the date of your reply; you wrote one, did you not?—I did write one and forwarded it to Mr. Bramwell, that was within two or three weeks of the date of Mr. Hemans' letter, and Mr. Bramwell sent it to the Board before their next meeting.

956. Was that also printed?—No, that was never printed.

957. Did they assign any reason for not printing it?—Mr. Bramwell told me that the Board assigned as a reason for not printing it that inasmuch as Messrs. Napier and Hope's scheme had been withdrawn it was considered not necessary to do so. They had not paid the deposit money on their estimate, and they had withdrawn their application for the concession, and therefore it was supposed that the whole matter was at an end.

958. Do you say that Mr. Hemans' letter was printed after the application had been withdrawn?—Yes, that was so.

959. Did they refuse to print your letter after that?—Yes, they printed Mr. Hemans' letter, but they did not print my reply.

960. You stated that you considered Messrs. Napier and Hope's scheme to be impracticable; will you describe your objections to that scheme?—The most important objection is as regards the embankments which are proposed to be built between two and three miles out to sea. From Foulness Point in a north-easterly direction the wall would extend about four miles into the sea, and if built in those situations the eastern or south-eastern wall would be as nearly as possible in 20 feet of water, and the northern and southern portions would be in a depth of water varying from 20 feet at the lower point to three or four feet, where they join the present shore.

961. Did you say that that long piece of wall from Foulness Point that borders on the edge of the deep water would be in 20 feet of water?—No; the south-eastern wall would be in the deepest water.

962. How much of that would be in 20 feet of water?—From the deposited plans, I made out at the time that about nine miles of the wall on Foulness would be in 20 feet of water, and the other six miles in a depth varying from three or four feet to 20 feet.

963. And in that other bit on the Dengie Flats, would there be any of that in 20 feet of water, and if so, how much?—I think the whole of the eastern part would be in 20 feet of water. The whole length is about 10 miles; and of that five or six miles would be in deep water, and about four or five miles in shallow water.

964. The whole length, Mr. Hemans has stated, is 26 miles; and, according to your statement, 15 miles of that would be in 20 feet of water?—That is so; I think 26 miles is about the length of the two walls, and about 16 miles is in deep water.

965. Did you verify this in any way?—Yes; I took some sections on the sands, and they quite bore out Mr. Hemans' own sections.

966. Does that statement agree with the deposited plans?—The deposited plans are quite correct as far as I took any sections that would enable me to test them.

967. Do the deposited plans show that about 15 miles of that wall would be in 20 feet of water?—Yes; on the deposited plans the top of the proposed wall is shown at the same level as the present wall, and the tides rise to within four or five feet of this. There is a figured height of 25 feet as the height of the sea-wall on the Parliamentary sections, and that height applies not merely at a particular point; it is a height which extends all the way along where the wall is near the line of low water.

968. Mr. Hemans has stated that very little of the wall indeed would be in 20 feet of water; is that correct, in your opinion?—If the wall is intended to be built where it is shown on the Parliamentary plans, there is no question that it would be in nearly 20 feet of water; of course, if it is intended to put the wall where there is not so much water, that is quite possible, but you would not enclose the same amount of area.

969. Mr. Hemans, in his reply to you, uses these words: "It is not, however, intended, as Mr. Hopkins imagines, to build the proposed embankment three or four miles out to sea, or in situations where there will ever be nearly so much as 20 feet of water upon them." And in his evidence, at Question 489, he is asked: "How deep is the sea at spring-tides along the line of your proposed wall? I have taken it at an average depth of from 11 to 12 feet; in some parts it would be more, and in other parts it would be considerably less; but an average of 12 feet would be rather a large average to take"; is that correct?—That does not agree with the Parliamentary plans; because 11 or 12 feet would not be a fair average as shown on them. I take the height from them, and they certainly show more.

970. As regards the depth of the sands themselves, did you take any borings so as to find out the depth of the sand?—No, I did not take any borings, but I did the next best thing to that, I ascertained that there had been a great many wells sunk on Foulness Island, and that the strata pierced by those wells were almost identical; that after getting through the surface soil, which is the soil warped up over those sands, there was invariably found a depth of 40 feet of sand, of just the same nature as the sands that are outside uninclosed, and there being 40 feet of sand under the part of the island which has been reclaimed, there seems to be no reason to doubt that there is 40 feet outside.

971. Do you consider that conclusively shows that the depth of the sand is 40 feet?—It was conclusive

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conclusive to my mind. I may mention that in a part of Foulness recently enclosed, called Newland, 40 feet of sand was found on sinking a well there, and that land about 50 years ago was a part of the outside sands.

972. As this embankment wall is to be in parts in 20 feet o water, what should be the height of the walls?—The present wall is about five feet above high water, and the new walls ought certainly to be a little more than that. I heard Mr. Hemans examined, and heard him state that the wall would be 26 feet down to the bottom, that would be allowing six feet above high water mark, that is the least I think it can be. I stated in my report that it ought to be from 25 to 30 feet, and six feet above high water is not too much for the walls in that exposed situation.

973. What would be the size and spread of those walls in comparison to those which now exist on Foulness Island?—The present walls on Foulness Island are about seven feet high, and they have slopes of three to one next the sea, and about two to one next the island.

974. What would be the base of those walls?—The base is about 35 feet. There is one part of the island, the north part next the Crouch, which is more exposed than other part , and here there is a more expensive kind of wall, and the slopes are four to one. As a rule, the walls are not pitched with stone, they are pitched with chalk in some places, but in this part next the Crouch it has been found necessary to pitch it with Kentish rag, and there the slopes are four to one.

975. Judging from those walls, what would be the base of the walls that are 26 feet high?—Assuming the wall to be 26 feet high, the slopes ought to be four to one, I should say, next the sea, and two to one inside; that would be 156 feet, or 52 yards wide at the base.

976. What are the existing walls on Foulness Island made of?—They are constructed of the warped up soil on the island, which forms a very stiff clay; there are a good many miles of this sort of wall merely turfed with grass. In some places they are obliged to put a facing of chalk rock, and in the case which I have mentioned next the Crouch, they are obliged to put a facing of Kentish rag stone.

977. Could you describe Foulness Island and the coasts where these works are to be constructed?—Foulness Island contains, I think, a little over 6,000 acres. It is wholly under the level of high water, and a great deal of it has been reclaimed from the sea. It is mostly arable land now, and the soil is not very deep. It is about three feet deep on the eastern side, and I think as much as five or six feet, or perhaps seven feet on the western side. It is surrounded by a sea wall about seven feet high, and immediately outside lie the Foulness and Maplin Sands, which extend from the present coast line down to the West Swin Channel, which is the principal entrance to the port of London.

978. Is that a deep channel?—It is; I think it is the principal entrance for ships coming from the North Sea and the Baltic, entering the port of London, and those sands form an inclined foreshore falling about five feet in a mile from the present embankment.

979. And how many miles out do those sands run? — From three and four miles, but the distance varies.

980. If that long slope of sand forms a sort of foreshore, then, what would do for the walls inside, namely, round Foulness Island might, perhaps, not do for the walls outside; could you argue from the one to the other?—It must follow that, if you enclose the foreshore, there is so much less foreshore left for the new walls; the present sands form an excellent breakwater for the present walls; but if you enclose that space, you have very little foreshore left. It is the foreshore which they propose to reclaim.

981. Then, in fact, you cannot compare the present walls with the walls that are to be built as to structure and strength?—Certainly not; whatever may be necessary, and is found to be quite sufficient for the present walls, would not at all do for the new walls; they are so differently circumstanced, that there is no comparison between the two. In fact, very little sea breaks on the present walls now; the force of the sea is expended on the sands before it reaches the walls; but out where the new walls are to be, there would be a great depth of water breaking on the walls, and they would be exceedingly exposed.

982. What is the nature of those sands?—I believe them to be quicksands.

983. If a vessel grounded on them, would that vessel sink and disappear?—I was informed, when at Foulness Island, that that was invariably so; the sands are remarkably fine-grained, and it is not an uncommon thing, I believe, near the edge of the Swin, for there to be as much as two or three feet difference in level on those sands in any one tide; with a strong north-east wind, the sands will vary as much as two or three feet in elevation.

984. Is that from the water getting mixed up with the sand, or getting underneath it?—Those sands are covered every tide, and at the edge of the channel they are quite alive, and are easily moved by the action of the water. They are exposed to the whole force of the North Sea; there is no headland, or anything to protect them, and the heavy seas from the German Ocean, with a north and north-east wind, have nothing to impede their breaking on this coast with great fury.

985. Mr. Hemans, in his examination on the last day of the meeting of the Committee, drew a parallel between the case of Morecambe Bay and these sands; he stated that the sands there were enclosed by an embankment of precisely the same nature as those which are proposed to be constructed here, and that as those embankments were safe, therefore these might be expected to be safe; do you concur in that opinion?—I heard Mr. Hemans give that evidence, and I took the trouble to procure a map of Morecambe Bay, for the purpose of making the comparison, but unless the situations are identical, I apprehend that the circumstances would not be the same. Morecambe Bay is so differently situated from the Foulness Sands, that I apprehend it is not a parallel case at all. That is an estuary of about 10 miles wide at the mouth, and there is a foreshore of sand of about 18 miles in length.

986. Would not that foreshore protect the embankment?—Yes; but in the case of the Maplin Sands it is just the reverse, whereas Morecambe Bay is an indent, and the walls are situated quite inland at the head of the bay. The Maplin Sands are jutting out into the sea, and there is no protection whatever to these walls.

987. Then it is quite a fallacy, is it not, to suppose that you can argue from this Morecambe Bay embankment to the Maplin embankment?—I do not think the two cases are at all similar.

988. With

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988. With what materials would you construct those walls?—There is very little, but the sands themselves on the spot, or near to it.

989. Would that be a good material?—No; I should think it would be a very bad one; in the present state of the sands they are covered every six hours with the tide, and when you attempt to dig them up, there is as much water as sand amongst them; I could not conceive a worse material.

990. Could that water be drained out from the sand before using it?—The water could probably be drained out after the embankments were made; but inasmuch as the sand is wanted for the purpose of making the embankment, that is rather a difficult problem to solve. The sands might be used if they were dry; but they are in a most unsatisfactory state to use as they are now.

991. Would there be any way of making them dry while they were being used?—Only by reclaiming a piece at a time, and making other walls to protect those pieces as they were reclaimed.

992. But even then you would have to put the sand in wet, would you not?—Certainly, unless the sand or other materials are brought from other places.

993. Do you consider that there would be any other difficulties in making the embankment with the sand?—The works would be subjected to interruption every tide; the sands are covered every six hours.

994. How long a time could they work between the tides there?—The sands are covered at about two hours flood; there would not be more than three or four hours available time next the low water.

995. Would they be able to work three or four hours a day?—They would be able to work three or four hours each tide; that would be at each low water, or three or four hours each 12 hours; but that would be diminished, because low water occurs in the night as often as it does in the day, and therefore the time for carrying on the work would be so much lessened.

996. Are there any other materials with which the embankment could be made?—Yes, other materials can be obtained; they can get chalk from Gravesend and Grays, and they can get plenty of Kentish rag from the Medway.

997. What would be the price of delivering the chalk and the Kentish rag at Foulness?—The price that is now paid, and they have it in large quantities, is for chalk, from 2 *s.* to 2 *s.* 6 *d.* a ton, and for Kentish rag stone, from 3 *s.* 6 *d.* to 4 *s.* a ton.

998. Then, would not that very much increase the cost of making the embankment?—Yes, inasmuch as the sand would be obtained for nothing, the chalk or rag stone would be so much additional cost.

999. Are there no other materials that could be got at a cheaper rate than those?—I noticed, in examining the Parliamentary plans, that there are about 600 acres of land over which Parliamentary power is taken in Foulness Island, at the points where the proposed wall joins the present wall.

1000. Do you mean that the limits of deviation cover about 600 acres?—The limits of deviation include about 600 acres of the present island, and it struck me at the time that unless it was intended to use that land for the new sea walls, I could not conceive what it could possibly be wanted for. I never heard any explanation of it.

1001. Do you mean that they propose to dig out the present land in order to reclaim other land?—I suppose so, if that part is to be used for making the embankment.

1002. Do you mean that they propose to use good soil in order to reclaim quicksand?—Yes; and the same thing occurs at the upper part of the Dengie Flats. There is a large quantity of land there over which power is taken, which can be wanted for no other purpose that I can see. It cannot possibly be wanted for the culvert, because that is in a different situation, and other land is taken for that.

1003. What quantity of soil could be obtained from those 600 acres to make the embankment with?—I do not think there is more than about three feet of soil, and taking 600 acres at an average of a yard deep, it would give 2,904,000 cubic yards.

1004. Would that go far in making the 26 miles of embankment?—Yes; I daresay if they used the whole for the banks, it would make some six or seven miles of it.

1005. It would not make more than that?—I think not.

1006. Is it a clay soil, or of what nature is it?—Yes; the top soil of Foulness is a very stiff clay, even after it has been cultivated for some years.

1007. If the embankment were made with chalk or Kentish rag, or this heavy clay, would it not sink into the quicksands, just as a ship would sink into them?—I think that if the wall were built with any compact material, such as stone or chalk, it would go down into the sands, but if the wall was constructed of the sand itself I do not suppose that it would, because it is weight for weight.

1008. You stated, did you not, that the progress of the works would be very much interfered with by the rising of the tides?—The site of the works must be covered at every tide, both with the ebb and flow. That must necessarily be so, because the works are near the line of low water.

1009. Considering the scarcity and cost of the material, the nature of the sand and the roughness of the sea, and the exposure of the coast, do you think that this embankment, supposing an Act of Parliament were obtained for the purpose, could ever be carried out?—I think that, taking into consideration the cost of the wall itself, added to the contingencies which may arise from interruption of the works, and from the works being washed away, and the short time that there is to execute them in, it is quite possible that the idea of reclaiming those sands would be abandoned.

1010. Mr. Hemans, on the last day of the meeting of the Committee, mentioned a good deal about the system of warping for reclaiming lands; will you be good enough to explain the nature of warping?—I think I heard Mr. Hemans say that a common mode of warping was to place some obstacle on the sand merely to intercept the water during the ebb, so as to allow it to settle a deposit over that part; that is not exactly the action which takes place here, whatever is going on in the shape of warping is entirely the work of nature; there are no artificial means taken for warping. At the present time those sands are gradually being covered with a thick mud deposit.

1011. Is the process a very slow one; could you give

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give the Committee any idea of the rapidity with which three feet of soil, for instance, is accumulated?—I think it must be very slow, and at the two extreme points I think there can be no accretion at all, for at the mouth of the Blackwater river there is an old Roman station on the coast, and at Shoeburyness there is a Danish entrenchment on the coast, so that certainly from those times there can have been no increase at the two extreme points. That would leave the whole of the accretion to take place at the mouth of the Crouch.

1012. How many miles would that be at the outside?—It would form a triangular shaped figure of about 16 miles along the coast, with about four or five miles at the apex extending from the coast up to Burnham.

1013. That would be four miles in about 1,000 years would it not?—I mean that at the extreme points there has been no accretion for 1,000 years. But I can give no information as to the time or rate of accretion. The last piece that has been enclosed on Foulness is this place called Newland which I have before alluded to; it was enclosed about 50 years since, that was the last enclosure, but I believe the rate of accretion is very slow; I have seen it stated that the warp is carried across the sands on to the Yantlet Flats, on the Kentish coast.

1014. Then the accretion would occur on the Kentish coast?—The accretion would occur on the Kentish coast in that case.

1015. You mentioned that an Act had been obtained in the year 1852; what works were carried out under that Act of Parliament?—There have been none whatever.

1016. That Act was for reclaiming these very sands, was it not?—Quite so, for reclaiming the Foulness, Maplin, and Dengie Sands. There were also powers in the Bill to enclose the foreshores of the Blackwater, but I think that the whole or nearly all of those powers were struck out.

1017. What is the navigation near those sands; is it dangerous and intricate?—The whole of the navigation in front of those sands is very intricate. There are a number of channels which are very shallow and are shifting their course very much. There is a great quantity of sand lying outside, and the channels at the present moment are just sufficient for what is necessary and no more. There is a great action going on with those sands, and the whole coast seems alive.

1018. Is this the course which all the ships take from the north to London?—They must come through one of these channels. I think the majority come through the West Swin Channel.

1019. Would this embankment render the navigation more difficult or dangerous?—If the walls are extended out into the sea, you rob the sands of so much space, I think it was stated to be 35 square miles. Mr. Hemans stated the other day that it invariably happens, whenever a new wall is constructed, that the sands accumulate outside those walls. That being so, it seems to me that the Swin Channel would certainly be endangered, and in all probability the entrance to the Crouch also. I have here a chart which accompanied the report of the Admiralty inspector upon the scheme of 1852, which shows the sands and all the channels.

1020. Did he corroborate the opinion that you have just stated?—Very much so, but in much stronger language. He remonstrated against anything being done on those Maplin Sands, and it was his opinion that anything done there would be exceedingly hazardous.

1021. With regard to that Bill that passed, what course did he recommend the Admiralty to adopt?—He recommended that the Bill should not go on at all, I think. In the concluding paragraph of his report he states, "I venture, therefore, respectfully to recommend the Lords of the Admiralty to withhold their assent to this measure, for it appears to me that it would be a difficult matter to frame clauses for the Act by which the interests of the public under the jurisdiction of the Admiralty can be sufficiently protected; nor can there be any reason for granting to a company an Act of Parliament for this scheme, seeing that what of it is likely to prove prejudicial to the public being cancelled, what remains is not likely to be beneficial to the general body of promoters."

1022. You state that the Act was passed; were any clauses introduced into that Act by the Admiralty?—Yes; the Act received the Royal assent on the 17th of June 1852, and the clauses referring to the Admiralty extend from clause 34 to clause 41, both inclusive.

1023. Are they very stringent clauses?—Yes, they are.

1024. Will you state shortly the nature of those clauses?—I know that one clause states not only that if any injurious alteration took place in any of the channels, but if any injurious alteration was likely to take place in any of the channels, the company should then remove such of the walls as the Board thought fit, and failing that being done, the Board had power to do it themselves.

1025. Would not those clauses prevent the works from being carried out if the Act was passed?—I do not know who would like to carry out works in the face of such clauses as those.

1026. If it was necessary to insert those clauses in the Bill of 1852, would it not be equally necessary in 1864?—No doubt.

1027. Such clauses introduced into the Bill of Messrs. Napier and Hope would prevent their carrying out their scheme, would they not?—Perhaps they might.

1028. Did you make any estimate of the cost of the proposed works?—No, I did not of the entire scheme; I made an estimate of the sea-wall at the time.

1029. How many cubic yards did that contain?—Where the embankment is 26 feet high the quantity of cubic yards, taking the slopes at four to one next the sea, and two to one next the shore, is 427,680 cubic yards per mile.

1030. What would be the price of that if it could be constructed of sand?—If you take that quantity at a shilling a yard, which is a common average price for railway embankments, it will give 21,384 *l.* per mile forward, and taking 16 miles of that, it would be 342,144 *l.*

1031. And if it were constructed of Kentish rag or chalk, what would it cost?—That would hardly be complete; what I have given is only for the part where the embankment is 26 feet high; the other portions of the embankment where it is a less height would contain on an average 190,080 cubic yards per mile, which taken at a shilling, would be 9,504 *l.* per mile, so that 10 miles of that would amount to 95,040 *l.*, which added to the 342,144 *l.*, gives 437,184 *l.* That would be the cost of the embankment if it could be done at 1 *s.* a yard.

1032. If it were constructed of chalk or Kentish

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Kentish rag, what would be the price of it?—I can only tell you what it would be if it were faced with it. If half of it is pitched or paved with Kentish rag, it would come to 110,880 *l.* additional, and 73,920 *l.* for chalk, that is for the remainder. I suppose that half is obliged to be done with stone, and half with chalk, together 184,800 *l.*

1033. That is, on the supposition that those walls were built on the surface of the sand, in which case you stated that they would probably sink in; what would be the price if you were to go down through the 40 feet of sand to the solid foundation?—I made one estimate, that, supposing the banks to be carried down from the base through the 40 feet of sand, as wide as the base of the wall only, it would make an additional quantity of 25,850,880 cubic yards, which, at 1 *s.* a yard, would be about 1,292,000 *l.*

1034. But you could not use sand there, could you?—Certainly not.

1035. Then you would have to use stone or Kentish rag?—I have not gone into the cost of chalk or Kentish rag for this; it would come to something enormous, because it is about 3 *s.* 6 *d.* a ton for stone, and 2 *s.* a ton for chalk.

1036. And to that you would have to add the price of the culvert which Mr. Hemans stated extended for 44 miles?—There is another item in the cost of the bank. I only gave you the cost of the sand and the chalk facing, and the rag stone facing. The whole of the bank must be puddled with clay both on the outer face and on the inner face. I think that that is the way in which Mr. Hemans proposes to make it, and that would come to about 80,000 *l.*, which must be added under all circumstances to the other figures, even if you usé the sand.

1037. If you are to add the price of making the 44 miles of culvert, could you give the Committee any notion of the cost of the works?—I have not made any estimate of the other works.

1038. Mr. Hemans stated that there were streams running out over those sands, and that it would not be necessary to make an embankment or wall at the edge of those streams; did you hear that statement?—Yes; I heard that; but I think that there was a little misapprehension about it at the time; there are no outlets across the Foulness Sands; the outlets are on the Dengie Flats; but on Foulness Sands there are seven openings ings along the eastern shore of Foulness Island, which are inlets and require to be supplied with water when the tide is up. There are no outlets at all from the eastern side of Foulness Island running across the sands; but there are, on the Dengie Flats, and the streams across the Dengie Flats, no doubt, could be provided for, as Mr. Hemans stated, by making the channel across the reclaimed land, and a catch water drain inside the bank

1039. Why do those inlets on the Maplin Sands require to be supplied with water from the sea?—The whole of the island is intersected by water-ditches which require to be filled very frequently from the sea. There are no other fences on the island but those water-ditches; and I was told that it was also very essential to the health of the island that those ditches should be kept pretty full. They prevent cattle from straying, and they emit a very disagreeable odour when dry.

1040. Do you mean to say that if those sands were reclaimed you would have to make an embankment across them to enable the water to run from the sea into those ditches?—The inlets would have to be supplied with water either by an embankment across the sands or by supplying it along the coast line. For taking water from the mainland to the sea you need no embankment in the reclaimed space, but if it is required to take the water from the sea into the island then you must have an embankment on the sides of those streams, because you can only let the water in at high tide.

1041. Sir *Joseph Paxton.*] How far do these inlets go into the country?—Only two or three miles at Foulness.

1042. Is there an Act of Parliament taking power to stop them up?—No, on the contrary, in the Act of Parliameut there is a special provision that they shall be left open.

1043. *Chairman.*] Then in that case must you not have embankments along the edges of those channels?—Yes.

1044. Assuming that all those embankments could be made and the sewage brought on to the sands, how long a time do you think it would take to produce any depth of soil on those sands before the tillage could be commenced?—The increase of soil is very slow indeed; I think it was stated in evidence that in Edinburgh, after 40 years, there was only about half an inch of deposit.

1045. Would not the water contained in the sewage have to be discharged into the sea, and only the solid matter or deposit left behind?—Yes, I understand Mr. Hemans to say that he proposes to pass the whole of the sewage over the sands, and to use the sands in fact as a filter bed; to have ditches two or three feet underneath the surface, which would carry off either the rain water falling on the enclosed space, and also the water which would run away from the sewage.

1046. Would there not be a danger of the sewage itself running away also?—I think there would; and I do not think the water, from the sewage after it had gone through the sands, would be quite pure water.

1047. Are you aware that in the report on the Metropolitan Drainage it is stated that if the sewage runs into the sea at the River Crouch, it would not go out to sea, but would hang about the coast?—I am not aware whether that is so. There is a popular error down there that the sewage of London now ultimately finds a resting place on those sands, which, as Mr. Gordon (the Admiralty inspector) explains, arises from the sands being quite black. Directly you remove the surface of those sands, they are quite black, but the blackness disappears when they are exposed to heat, and I believe it is derived from decomposed seaweed. Mr. Gordon had the sand analysed, and there was no trace of sewage found in it.

1048. Would there be any objection to the sewage water being drained off, and flowing into the sea at this part?—There certainly would, so far as the Crouch is concerned. Foulness Point is about five or six miles below Burnham, and between Burnham and the point are numerous oyster beds. All the Burnham oysters come from this district, and so far as they are concerned I think they would be damaged and perhaps destroyed. I know that mud of any sort is detrimental to oysters. I know that at Newhaven they are obliged to turn the oysters over at every tide to wash the mud away from them to prevent their being choked.

1049. Mr. Hemans stated that if the walls were built

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built on the sand the sea-water would not come underneath again and fill the reclaimed land with sea-water; is that your opinion?—If the embankment is to be constructed, as Mr. Hemans stated, of sand, and placed on the sands, I think it is extremely probable that it would come underneath, for you have a head of 20 feet of water exerting a pressure outside, and you have nothing inside the reclaimed space to counterbalance that. If the embankment, or if even the puddle was carried through the 40 feet, that would no doubt stop it effectually; but I do not think that the weight of the bank itself would. The pressure of the bank on those sands, even taking it at 26 feet high, would not be more than a ton and a-half or two tons on the square foot, and that on the sand, or rather sand and water, would not squeeze out the water and leave the sand dry, although it would displace a certain quantity of water.

1050. In fact it would sink in, would it not?—I have no doubt that would be so.

1051. If this were the case, and the salt water got underneath, would not that hinder the process of reclamation?—That would stop it altogether, because nothing is so injurious to agriculture as salt water.

1052. Mr. Hemans stated, in his evidence, that along the 17 miles on the one side, and the eight miles on the other side, where the culvert would be open, there was no population; is that so?—I suppose he was speaking figuratively; there is a population of some sort; it is not a populous district; but Foulness, I think, contains something like 600 inhabitants; and there is the town of Burnham, containing 2,000 inhabitants. It may be described as thinly populated; but to say there is no population is not correct.

1053. And would they endure a nuisance from those open culverts?—Yes; it was that which alarmed Mr. Finch, those open culverts, and bringing down the whole of the sewage from the north side of the metropolis to be discharged on those sands.

1054. Have you turned your attention at all to the means which they propose to employ for conveying the sewage to Foulness Island?—To some extent, I did; I had all the plans before me. They propose to take the sewage from the pumping station at Abbey Mills, and to bring it down as far as the 37th mile in a covered culvert: from that point the two branches were to be opened; the covered culvert was often underground, and sometimes above-ground, as necessarily it must be, because it would be necessary to get a uniform fall from one point to the other.

1055. Mr. Hemans stated that the sewage would be delivered at each side of the culvert on the adjoining land; would that be possible?—I do not say it would be impossible; but it could not be delivered by gravitation where it is below the surface of the ground, and there pumping would have to be resorted to.

1056. Then the area would be very small to which it could be delivered without pumping?—Yes; Mr. Hemans said along one-third or one-fourth of its length; and I think he has struck out one-half of that by abandoning the branch to the Dengie Flats, and that would reduce it to one-sixth or one-eighth.

1057. Supposing that it were finished, would it pay at all as a mercantile speculation; or would it be remunerative to the ratepayers of London?—If the sewage of London is of anything like the value which is attributed to it, I do not see how it can possibly pay to put such an enormous quantity on this small space, even with the addition of distributing in places where it is possible to do so along the side of the culvert.

1058. What does the land in Foulness Island let for at the present moment?—I think it is about 40 *s.* per acre, not more.

1059. Is it your opinion that this scheme is likely to be advantageous either to the Company or to the ratepayers?—I do not think that the value of the sewage could be realised by this scheme; its principal feature has been copied from what has been done at Craigentinny; but one is almost afraid to say what the London sewage is probably worth; I do not see how it can be realised by this scheme.

1060. Would the company be reimbursed for their outlay?—I should very much doubt it.

1061. Are you aware that the former scheme of Messrs. Napier and Hope has been very much modified this year, and, in fact, is almost a new scheme?—Yes; in their previous tender, which I have read, they proposed to put the whole of the sewage on those sands only. Nothing was said about delivering by gravitation along the line of the culvert, and now I hear that the Dengie Flats are abandoned, and that they propose to distribute whatever they can by gravitation along the culvert instead.

1062. Are you aware whether that change of scheme has been made since this Committee was appointed?—It has. The date of the letter containing the altered scheme, and which is published by Mr. Stanford, of Charing-cross, is subsequent to the appointment of this Committee.

1063. Then they determined to abandon the Dengie Flats altogether, and to deliver the sewage over some 30,000 acres, intervening between Abbey Mills and Foulness Island?—Yes; I think Mr. Hemans said that the culvert would probably command about 30,000 acres, but some of this, probably one-half, is along the portion of the culvert which is now abandoned.

1064. Supposing that the Admiralty were to interfere, as you think it very likely they would, then the company would have to fall back entirely on those 30,000 acres, would they not?—Yes.

1065. Do you think that this is likely to happen?—We have seen that it has happened once. This Bill has been passed before, and nothing whatever has been done to carry out the works. I believe that the Act is still in force, and that they had 21 years to carry it out.

1066. Is the Act still in existence?—I think the Act was to be in force for 21 years.

1067. In that case, would not the area for the distribution of the sewage, namely that of 30,000 acres, be very small?—That would be totally inadequate to its proper use.

1068. Then, to realise any profits themselves or to reimburse the ratepayers, they would be driven to some other course, would they not?—They would be driven then to enlarge the area, no doubt. If the sewage has anything like the value which is assigned to it, even by those who give the lowest estimate, it could not be realised on that area.

1069. Are you aware that it is only the dry-weather sewage which they propose to take?—Yes.

1070. Is not the sewage which flows out in heavy storms as rich or richer than the dry-weather sewage?—I believe that the sewage which is brought down by the storm-waters is richer than the ordinary sewage.

1071. Would

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1071. Would it not be desirable to use that, instead of sending it out into the Thames?—I should think it would be very desirable to utilise it, and keep the Thames free from it.

1072. Have you read the other tenders which have been sent in?—Yes.

1073. As an engineer, do you consider any of them to be practicable?—Yes, I do not see why they should not be; this very scheme no doubt is practicable to a certain extent: and perhaps the embankment itself is practicable, if you choose to spend enough money over it.

1074. But, in a remunerative point of view, as a commercial speculation, do you think that any of those schemes would answer?—I am hardly prepared to answer that question, but I should think they would.

1075. Would it be very costly to pump the sewage up into some reservoir on a height, so as to allow it to gravitate over the country?—No; that is not a costly operation. Cornish engines can be employed, and are employed, to lift enormous quantities of water at very little cost.

1076. As London is in a basin, if you wanted to utilise the sewage by gravitation, you must have resort to something of that sort, must you not?—Yes, certainly; and if the reclamation of the Maplin sands be abandoned, the promoters of the scheme for using the sewage from the north side of the metropolis would be driven to make some such arrangement.

1077. Have you made any calculation as to what the cost of the pumping would be?—No, I have not; but I know it is the fact that enormous quantities of water can be pumped to a great height, at an almost incredibly small cost.

1078. Did you read the scheme of Lord Torrington and Sir Charles Fox?—Yes; I read them all.

1079. What is your opinion of that scheme?—I am not sure that I quite understand that scheme; I presume they think that their case would be injured by putting it fully before the public; but I am not quite sure about it.

1080. They propose to put it over a large area, do they not?—They propose to put it over 300,000 or 400,000 acres. At first, if I remember rightly, it was over 30,000 or 40,000 acres which they proposed to purchase, but afterwards, I think, they did not propose to purchase the land, but to lease it.

1081. Mr. *F. North.*] With regard to the old walls of Foulness, do you happen to know what the foundation of those is?—I think they are built on the clay.

1082. Has the wall underneath it any quantity of this quicksand that you have mentioned?—Yes, it has the same depth of sand underneath as there would be under the new walls.

1083. Then the same conditions that would apply to the sea coming in under the new wall must have applied to the Foulness wall?—With this exception, that outside the present walls there is at spring tide a head of water of about three feet only, and on the island you have the sands covered with about three feet of compact clay to counteract it, whereas on the new wall you have a head of 20 feet of water outside and nothing inside.

1084. Then the old wall is built under better conditions than this would be?—Yes, it is built on the warp on a stiff clay; the wall, perhaps, will settle down on that a little.

1085. Mr. *Caird.*] Do you wish the Committee to understand that Messrs. Napier and Hope's scheme was withdrawn in consequence of your report?—No, I do not think it was.

1086. You did not wish the Committee to understand that?—No; it was withdrawn a few days after my report was sent in.

1087. But not in consequence of it, so far as you know?—No; the scheme had already lapsed in consequence of the deposit not being paid.

1088. Is your objection to their scheme purely an engineering one as to the impracticability, in your opinion, of embanking on those sands?—Yes; principally, I have not entered into the question of the commercial success of the scheme.

1089. And provided they could dispose of the whole of the sewage on the whole length of the 44 miles on its way to the Foulness sands, your objection would not hold?—Just so. If they could dispose of the whole of the sewage profitably, then the reclamation of the sands would become unnecessary.

1090. You stated that the fact of the removal of the foreshore being objectionable at any time for the reason that it would take away the natural protection of the shore would be an objection to this scheme, but would it not be an equal objection to any scheme for the reclamation of land from the sea?—Certainly, but the objection is greater in some cases than in others; if you take away the foreshore, which is the natural protection of the bank, you must provide other means for its protection.

1091. But would you, for that reason, refuse altogether to go into any scheme for reclaiming land from the sea?—Certainly not; it is a question of what money you choose to spend on the works.

1092. Would not any work of this kind be liable to interruptions from the tide?—All similar works would be liable to interruptions from the tide.

1093. So that that is no special objection to this work?—I only mentioned it in this way. The works being near the line of low-water, must, of necessity, be very much interrupted in their progress, and this will increase the cost of construction.

1094. *Chairman.*] Will the sea break to a great height over this embankment wall, if it is built?—This part of the coast is very much exposed to the whole of the North Sea, and the storms there are very heavy. It is a very exposed situation; there is no protection at all from the large body of the North Sea, and, there being no headland to protect the works at all, the sea will break very heavily against them.

John James Moore, Esq., called in; and Examined.

J. J. *Moore*, Esq.

1095. *Chairman.*] You put in a tender, did you not, to utilise the sewage of the metropolis in a fluid state?—I did.

1096. Are you an Engineer?—I am engaged in agricultural engineering principally.

1097. How many different proposals did you make to the Metropolitan Board of Works?—I think I have made a proposal at each time that they have advertised, and I think they have advertised three times. I made a proposal in 1858.

1098. And

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1098. And did you again in 1860?—And again in 1860.

1099. And in February 1862 and in 1863?—I did.

1100. Were those different proposals?—They were modifications embracing the same principle.

1101. It appears that the Board was not furnished with your plan of distribution?—Not with the particulars of the distribution, because it would have taken such an immense expense to have made a survey of the lands that were engaged to receive the sewage.

1102. Did you give them a detailed calculation of the expense of the works and your annual working expenses?—I did not, because that would also have required a survey; it would have required a survey of the land and the altitude of the land also, which would have entailed great expense.

1103. In the proposal of 1860 you offered, did you not, if you got a lease for 90 years of the sewage, to give a peppercorn rent for 14 years, and after the 14 years to give half the profits, after deducting 10 per cent. on the capital?— That was the proposal.

1104. How much did you state your capital at?—We were to commence with 200,000 *l.*, to be increased to 500,000 *l.*

1105. In 1862, did you not propose to carry the sewage to 20,000 acres in Essex?—I stated that I had engaged the occupiers of 20,000 acres in Essex to receive the sewage.

1106. But you did not limit it to that?—Not by any means. I had engaged in 1846 occupiers of 70,000 acres to take the sewage of the Metropolitan Manure Company. I got up that Company in 1845-46; that was in Middlesex.

1107. Do you propose to raise it 200 feet by pumping, and then to let it fall by gravitation?—Not to pump it 200 feet in the first instance, but the extreme height would be 200 feet, or to require power to pump it 200 feet, because the average height of the land would not be 200 feet above Trinity high-water mark, but it would be required to be pumped to that height for the purpose of overcoming the friction.

1108. Did you propose that the Board of Works should find the steam power for you?—I proposed that as they were to have surplus power, if they would pump on an average the extreme height of 200 feet, I would ensure them a farthing a ton for pumping it; and as that would not cost them one-eighth of a penny per ton, there would be an eighth of a penny profit, which would amount to 136,000 *l.* a-year, according to the estimate of the quantity. I thought that that would be more satisfactory, for this reason, there has been no certainty about the quantity.

1109. Then the farthing a ton was not only to be the price for the sewage, but also compensation for the steam power?—Yes.

1110. You stated, did you not, that you had customers for the whole of the sewage?—I have customers for the whole of the sewage; but there are only 20,000 acres in Essex, with the owners and occupiers of which I have engaged.

1111. Over what area would you propose to distribute the sewage?—That would depend upon the mode of cultivation. The farmers who engaged to take it were not conversant with its application, and therefore I had to engage to direct its application. Of course, I could not expect that they would alter their mode of cultivation; but I was to apply it according to the mode of cultivation that they would require, and the cost would depend upon the mode of cultivation.

1112. Are you aware that the amount of the sewage of London is about 10,000,000 cubic feet per diem?—The quantity that Mr. Hawksley, who is the consulting engineer of the Metropolitan Board of Works, has estimated it at, after examining the subject thoroughly, is that there is an average of 80,000,000 gallons a-day, and that would be 130,000,000 of tons annually.

1113. What would you do with that amount annually?—That, at the rate of 5,000 tons per acre, would supply 26,000 acres; at 4,000 tons per acre, it would supply 32,500 acres; and at 3,000 tons an acre, about 43,300 acres.

1114. Over how many acres do you propose to distribute the sewage?—As I have stated, it would depend upon the mode of agriculture that was adopted. According to some systems, they would require 1,000 tons an acre.

1115. You are aware, are you not, that this 80,000,000 gallons would have to be distributed every day?—Every day.

1116. You have no idea over what amount of land you would distribute that amount?—That would depend upon the mode of cultivation, but it would not be more than from 30,000 to 50,000 acres.

1117. How many tons would those 80,000,000 gallons amount to?—There are 224 gallons to the ton; it would be 130,357,000 tons annually.

1118. What amount of horse power do you imagine that the Metropolitan Board of Works would have to use in order to lift the 80,000,000 gallons of sewage 200 feet during the 10 working hours of the day?—I have made that calculation, but I have not it with me.

1119. How would you make that calculation?—One horse-power is equal to 33,000 pounds lifted a foot in a certain time. That is the mode of calculation.

1120. That would be upwards of 8,000 horse-power net, would it not?—I suppose it would require that.

1121. And it would be about 15,454·5 gross horse-power?—I do not think that it would require that for the height.

1122. If it is 8,242·4 horse-power net, how much gross horse-power would it be?—That would depend upon the difference for friction.

1123. Do you know the rule for turning net horse-power into gross horse-power?—Yes; but the gross horse-power is the calculation for friction: it is proportioned to the distance.

1124. Do you know what it would cost the Board of Works to purchase, erect, and maintain that amount of horse-power?—I have not the calculations with me; but they have a surplus power, and I can see that there would be an advantage to them in using that surplus power, and so economising the whole.

1125. Have you brought any calculations with you?—I have not.

1126. Were you not aware that you were going to be examined on your tender?—The fact is that I have those calculations; but I came away hurriedly from home, and when I got here, I found that I had forgotten them.

1127. You offer the Board of Works a farthing a ton for the sewage, do you not?—Yes; which they would raise with a power equal to 200 feet.

1128. And do you estimate that at 136,000 *l.* annually?—The half of that would be a profit to them; because it would not cost them one-eighth of a penny per ton to lift it.

1129. Do not you give them a farthing a ton for the sewage?—I offer them a farthing a ton.

1130. And that, you state, would be 136,000 *l.* a-year?—It would.

1131. Is that 136,000 *l.* a-year to pay them for the sewage, and also for the steam-engines and steam-power that they would require?—Exactly.

1132. Is that all the rent that they would get for the 14 years?—That was a different tender; that proposal was to commence on the supply. The reason that the 14 years was mentioned was, because at that time it was stated that it would take a great portion of that time to have any return.

1133. *Lord Fermoy.*] Did you state that you were an agricultural engineer?—I did.

1134. Have you formed any idea in your own mind as to what is the largest quantity of liquid sewage that an acre of ground will take in a year?—I do not think that it would require more than 5,000 tons in a year to be distributed by irrigation.

1135. Do you propose to put the sewage on cultivated land?—Yes.

1136. How much of the sewage would cultivated land take?—That would depend upon the state that the land was in. A market gardener at present manures at the rate of 20 *l.* an acre with solid manure.

1137. And you propose to deliver the sewage at a certain price to him?—Yes.

1138. Do you fix any price as the basis of your calculation?—The price to the whole of the consumers is a penny a ton. I do not think that it would answer any farmer's purpose to pay more than that.

1139. How many tons to an acre would you put on irrigated land?—From 4,000 to 5,000 an acre; that would be about 20 *l.* an acre.

1140. How do you propose to carry the sewage through the country?—Entirely in iron pipes.

1141. You do not propose to carry any of it by a brick culvert?—No; because there would have to be a pressure on the pipes for delivery, and consequently a brick culvert would not answer the purpose.

1142. Do you propose to raise the liquid manure to the requisite height at once, and then to carry it off by gravitation?—The mode in which I propose to supply it is by pressure directly to the farmers. I conceive that it would not be advisable to put it into a reservoir for any length of time, for this reason, that in the summer season it would become decomposed, and would be injurious, whereas if it is kept in a continuous flowing state there would be no injury whatever.

1143. How do you propose to get that pressure?—By the direct action of pumping.

1144. There would be no head of water at all?—No.

1145. Do you calculate that the Board of Works could supply you with a continuous pumping at the rate of a farthing a ton, and that half that would be clear profit to them?—Yes, I am satisfied of that.

1146. That is to say, the cost to them would be one-eighth of a penny per ton to supply the sewage by continued pressure to the outfall?—The pipes would not stand more than a pressure of from 10 to 12 miles from the pumping station.

1147. You do not propose to carry it further than 10 miles from the pump?—Perhaps 10 or 12 miles, but not exceeding 15 miles, because the further it is conveyed the greater will be the expense, and the less valuable will be the produce, whereas the nearer it is supplied to town the more valuable will be the produce.

1148. Through what sized pipes do you propose to carry it?—Three pipes of 5 feet would be ample for the sewage of the north side of the metropolis. Again, it requires velocity; it is not advisable to have a slow motion, for this reason, that a sediment will be in the pipes, and they will become choked. That occurred with the pipes of the Metropolitan Sewage Manure Company at Stanley-bridge; their pipes were getting choked in consequence of there not being sufficient flow, and the sewage consequently becoming stagnant occasionally; hence it requires that the sewage should be delivered continuously with a certain velocity, to prevent the sediment from accumulating.

1149. Were those the main pipes?—They were the pipes altogether.

1150. Would all the pipes be 5 feet in diameter?—No, the service pipes would be in proportion to the supply to each farm. I am speaking of the mains.

1151. Would not the service pipes become stopped by sediment?—No, because they ought to be kept in a continuous flow night and day.

1152. Dr. *Brady.*] Would you keep the service on night and day?—Night and day.

1153. Would the pressure be on the service pipes equally with the main pipes?—It would be continuous.

1154. Then there is to be one pumping pressure from the outlet where you collect the sewage, going always at one time?—The flow of the sewage is not constant during the 24 hours. I think that Mr. Bazalgette states that about half the sewage is supplied in six hours out of the 24 hours. Mr. Hawkesley states that it is during eight hours, and Mr. Simpson that it is during 12 hours; but it is not continuous, because when they commence emptying the slops in the morning at the different houses, perhaps about six o'clock, the flow is continuous till 12 o'clock or two o'clock, and then towards the evening it is very light indeed, consequently there is a variation in the power.

1155. Mr. *Caird.*] Did you state that you had engaged the occupiers of 20,000 acres of land to take the sewage?—I have.

1156. Would you state to the Committee the kind of engagement which you have made with those occupiers?—That is given in my tender, which is contained, I believe, in the pamphlet which is already before the Committee. It is a short extract, and with the permission of the Committee I will read it: "Whereas the Metropolitan Board of Works, having to intercept the sewage of the metropolis from flowing into the Thames, and having no other outlet for it but the sea, while the agriculturists are so deficient in their supply of manure as to have it imported from the most distant countries at considerable expense. Therefore, we, the undersigned, owners and occupiers of land in the vicinity of the metropolis, being desirous of obtaining the sewage in a liquid state as manure, do hereby severally agree, engage, and bind ourselves to receive and consume the sewage continuously as manure, to the extent that it is capable of being so applied on our respective holdings, under the management of John James Moore, agricultural engineer, on the terms attached to our respective names, and which we severally agree to pay him for obtaining the transmission of the sewage to the most favourable situation on our respective holdings, and for his management thereof, and will

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will severally execute any deed or deeds necessary for the due fulfilment hereof when thereunto required."

1157. How many occupiers of land signed that agreement?—I think there are 90, and the extent I believe is 20,000 acres. The first name is William Adams, of Stratford, who has 1,000 acres, and another is John Allison, of Epping, who has 1,800 acres.

1158. Did you, before those persons subscribed their names to that agreement, affix a sum at which you could supply that liquid manure?—The sum is stated in the agreement; it is to be a penny a ton.

1159. Did you find 90 occupiers holding to the extent of 20,000 acres who were willing to sign and did sign such an agreement as you have read to the Committee just now?—I can produce to the Committee a book with the whole of their signatures.

1160. Have you that book here?—I have not got it here, but I can produce it. I found that very few of them thought it possible that the sewage could be supplied; they were not acquainted with the mode of its application, and they wished to ascertain whether it was to be supplied in the farm yards. I said no, if you have it in the farm yards it will cost sixpence or a shilling a ton to put it on the fields.

1161. Was their agreement to pay you a penny a ton for the sewage delivered on to their fields? —Upon their farms.

1162. Was it to be delivered on each field?—Of course not, they would have to incur the expense of distribution afterwards, according to the mode of cultivation.

1163. Were they aware that they would have to incur that additional expense?—Yes.

1164. Was that stated in your agreement with them?—The agreement is in these terms: "We, the undersigned owners and occupiers of land in the vicinity of the metropolis, being desirous of obtaining the sewage in a liquid state as manure, do hereby severally agree, engage, and bind ourselves to receive and consume the sewage continuously as manure, to the extent that it is capable of being so applied on our respective holdings, under the management of John James Moore, agricultural engineer, on the terms attached to our respective names, and which we severally agree to pay him for obtaining the transmission of the sewage to the most favourable situation on our respective holdings."

1165. Would not "the most favourable situation" mean each field?—"The most favourable situation" would not mean to each field; "the most favourable situations" of course would, but "situation" is one place.

1166. Did you only propose to take it to one point on each farm?—Only to one point on each farm.

1167. And did you explain to those people that they were to pay an additional rate for the further carriage of the sewage?—I explained that they would have to pay an additional expense for carriage, according to the different modes of cultivation.

1168. What expense did you tell them it would be?—I could not calculate that.

1169. Do you think that the agreement which you have read would be binding upon them when a further demand was made upon them beyond the penny?—It would not be a further demand; they would have it there, and they would have to pay the expense of its application.

1170. Was not their agreement founded upon the penny a ton?—It was. I knew that it would not be worth more to them, and therefore I did not propose more. I could not expect that they would enter into any engagement, unless they participated in the profit.

1171. They said that they would give you a penny a ton, and they expected, did they not, that they would have a supply of sewage whenever they wished to use it?—No, it was to be continuous whenever the farm was ready to receive it, because it would have to be used continuously.

1172. Who was to be the judge as to when the farm was to receive it?—It was to be under my management, and I was to be the judge, because there was not one that knew how to apply it. It would not be an advantage to give them more than would make a profit to them, and, of course, I took that responsibility.

1173. Sir *Frederick Smith.*] Were those holdings on level ground, generally speaking?—No, they were not. I should state that a great tract of ground, which some persons would think adapted for the application of the sewage, is not adapted for it at all. In the first place, the marsh land lets at a high rent at present; some of it lets at from 6 *l.* to 8 *l.* an acre, I believe. The land that I have engaged is principally undulating ground of a very porous nature, and that which is not porous is clay, well drained. To apply the sewage, it requires to be under complete control; and it would not do to allow it to accumulate on the soil, because it would become a nuisance; it must be absorbed in a flowing state; any interception or any pounding of it would create a nuisance.

1174. Then you did not intend to tank it, or to place it in reservoirs on any of the holdings? —I did not intend to impound it under any circumstances, it would be always flowing; because when impounded it becomes a nuisance, and it also deteriorates in value.

1175. Then you intended to deliver it at the highest possible level in each holding?—Yes.

1176. And did you propose to leave it to the occupiers of the farms to deliver it to the lower levels?—It would gravitate, but then it would require direction; it would require a system of distribution.

1177. What system do you propose for that? —There are a variety of systems; there is that by the jet, but I do not think that that is the best; I think that it can be applied in a flowing state.

1178. How do you propose to apply it over an undulating country?—Of course it will flow from the highest parts to the lowest.

1179. But then it meets in the course of its flowing with some rise, and how do you propose to deal with that?—The pipes would be so arranged that it would flow from the elevated parts.

1180. Have you calculated any expense for that?—There would be an expense, of course.

1181. Would not that be a heavy expense over an undulating country?—No, it is a falling country rather than an undulating country.

1182. "Undulating" was your own expression, was it not?—Yes, but the land above the marshes is separated by a line called the Ribble road, and there is a gradual ascent. I will furnish the Committee with any papers that may be necessary to explain fully my tender.

CHARLES HENRY CROMPTON ROBERTS, Esq., JAMES BRUNLEES, Esq., and GEORGE HERBERT TOWNSEND, Esq., called in; and Examined.

C. H. C. Roberts, Esq. *J. Brunlees*, Esq., and *G. H. Townsend*, Esq.

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1183. *Chairman.*] (To Mr. *Townsend.*) ARE you the Secretary to the projected Company called "The London Sewage Utilisation Company"?—I am. If the Committee wish for any details of the scheme, Mr. Roberts, the originator, and Mr. Brunlees, the engineer of the scheme will be able to supply any information on the subject that may be necessary.

1184. You propose to utilise the sewage in a fluid state, do you not?—Yes.

1185. In your letter of May 7th 1863 you refer the Board to a tender which you made in 1860; is that the case?—Yes.

1186. Are your plans now the same as they were in 1860?—Yes; they have undergone no modification. The Board had nearly concluded the arrangements with us.

1187. That was the plan of irrigation of Mr. Roberts?—Yes, who is here.

1188. From the letter of the 5th of July 1860, your Company does not appear to have been certain of the commercial value of the sewage. They say, Mr. Roberts's plans require to "be further tested, to prove practically that they contain commercially available elements"; are you still in doubt upon that point?—Those are points that I cannot speak upon, but Mr. Roberts is fully acquainted with the subject, and can speak to it.

1189. Is he one of the directors of your company?—Yes.

1190. (To Mr. *Roberts.*) In the letter of the 5th of July 1860, it is stated that your plans will require to be further tested, to prove practically that they contain commercially available elements; are you in any doubt whether the sewage does contain commercially available elements?—Personally not at all; but we believe that the public are still in doubt about it. Until it is definitely shown by experiments with the metropolitan sewage, the public will not believe that it is of so much value.

1191. Was it with that object that you wished to start with an experimental capital of 30,000 *l.*, in the first instance?—Quite so.

1192. But you estimated that to utilise the whole of the sewage would require a capital of 500,000 *l.*?—About that, including all contingencies.

1193. Then you propose to purchase lands, and carry on farming operations on those lands?—Either purchasing or taking leases.

1194. Then the directors must have power to purchase stock and sell the produce of those lands?—The company would generally.

1195. Then, if you are satisfied with the results obtained on that experiment, and if they are such as to induce you to raise that 500,000 *l.*, how much of that would have been necessary to purchase more land for your extended operations?—We did not propose that the 500,000 *l.* should cover the purchase of the land; that was the outlay on the works that would be necessary for placing on the land.

1196. Then how are you to get the lands to carry on the farming operations?—By taking leases of it.

1197. How much would you put for the stock and utensils for the farming?—We surveyed a portion of land, and this portion we estimated as sufficient for taking the sewage as it exists at present, and we calculate the cost of applying the sewage to each different acre of that land, and all the contingencies connected therewith, and the conclusion we come to is this, that 500,000 *l.* would very amply pay every expense.

1198. How much of that 500,000 *l.* would be required to purchase the stock and utensils?—We do not require any stock and utensils; our object was merely to grow the grass, and sell the grass when grown. We propose to apply the irrigation to grass land alone.

1199. You would never think of putting cattle on it, but you would mow it?—We should mow it entirely.

1200. Would you require no utensils, no carts to convey the grass?—We have taken sufficient capital to erect cow-sheds, and to let those sheds to cow-keepers, who would supply London with milk, and the cows would feed on this grass.

1201. How much of that 500,000 *l.* would be devoted to the rent of land?—The actual outlay in placing the sewage on that land was 200,000 *l.*

1202. Was that for the works?—That was for the works, pipes, hydrants, and everything connected with it.

1203. How many acres do you propose to deal with?—About 9,000 acres.

1204. Is that for the sewage of the whole of the metropolis?—For the north side, exclusive of the western area.

1205. Then could you not tell the rent?—We estimated the rent of the greater portion of it at 6 *l.* per acre; we found that the present rental was 5 *l.* 1 *s.* 6 *d.*, and going into the market and taking such a quantity, we calculated the rental would be 54,000 *l.* a-year.

1206. How much would be requisite for the annual working expenses?—It depends entirely upon what area the Noble Chairman refers to.

1207. Did you not calculate what your whole working expenses would be year by year?—I find that we reckoned, for labour, 1 *l.* an acre in every instance for putting it on, and the interest and cost of plant varied, of course, with the elevation at which the land was situated.

1208. What would be the interest on the cost of plant over those 9,000 acres?—We always calculate that at 7½ per cent.; 5 per cent. on the money, and 2½ per cent. for depreciation.

1209. That would make 63,000 *l.* as your annual expenses; how much more must be added to that?—Suppose you reckoned 1 *l.* an acre for labour, I find our working expenses, including the interest on capital and cost of plant, are 17 *s.* 8½ *d.* per acre.

1210. That would be about 72,000 *l.* a-year, would it not, that you would have to expend?—Yes.

1211. And do you suppose that the extra crops on that restricted area of 9,000 acres, would pay you?—We have no doubt about it.

1212. How much do you propose to give to the Board of Works for the sewage?—We propose to give them for a limited period of years a pepper-corn rent, and at the expiration of that time, to leave it to any number of engineers, or the Board of Trade, to settle what would be a fair rental for it.

1213. Have you come to any definite conclusion on the subject yourselves?—We had many meetings with the Board of Trade, and our idea was

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was to give them a pepper-corn rent of 5 *l.* for 14 years, or 21 years, in the first instance.

1214. Did you come to any conclusion as to what you should give them after that time?—We believe that, at the expiration of 21 years, the value of the sewage in the market will be very much higher than it is now. At the present moment the manure applied to land in the neighbourhood produces excellent grass; but there is no market for that grass, and it is now rotting on the land; it would be some time before a business is created, and it would be therefore some time before the Company could organise the business.

1215. Where are those 9,000 acres situated?—In the marshes, near the outfall in Essex.

1216. Then you would not require to pump?—We should, over 2,300 acres.

1217. Have you taken that into account?—Quite so.

1218. Then, I understand that the rent of the land and the working expenses will be above 70,000 *l.* a-year, and your capital will be 500,000 *l.*, is that so?—Yes; I should state that, in all those estimates, we propose at this cost to convey the sewage to the centre of every plot of ground; we have divided the ground into panes of about 10 acres each, and we have pipes which would convey it either to the centre or to the highest point.

1219. What would be the first cost of works to effect that distribution over the 9,000 acres?—Over the portion which is done at the cheapest rate, 1,700 acres, it would be 20,090 *l.*; over the next portion, where there is no pumping required, of 4,400 acres, the cost would be 100,538 *l.*; and over the portion, where we require to pump, the capital required will be 60,960 *l.*

1220. (To Mr. *Brunlees.*) What is the total cost of your works?—£. 181,588 is the cost of the whole works.

1221. (To Mr. *Roberts.*) And the working expenses have been shown to be 72,000 *l.* a-year; is that the case, counting the rent?—The rent we put at 7 *l.* an acre; so as to be sure to be right, it would be 83,172 *l.*

1222. Lord *Fermoy.*] (To Mr. *Brunlees.*) How do you propose to carry this sewage?—By cast-iron pipes.

1223. Is any of this land in the neighbourhood of the sea?—No; in the neighbourhood of the river Thames.

1224. Do you propose to embank anything?—We do not propose to embank.

1225. *Chairman.*] There is no pumping required, according to your plan, is there?—For the part which is coloured red, the sewage must be pumped 40 feet.

1226. Lord *Fermoy.*] Is this the whole of the 9,000 acres?—Yes.

1227. Is that all grass?—Excepting the pink part, it is.

1228. (To Mr. *Roberts.*) Then how do you propose to deal with the pink?—To lay it down in grass, the greater part of it.

1229. (To Mr. *Brunlees.*) How much of the 9,000 acres is marsh land?—Nearly all of it.

1230. How much of that sewage have you calculated, or have any of the gentlemen here present calculated, that you would propose to put on that marsh land?—The proposal was to put on about the same quantity that is put on the meadows at Edinburgh, from eight to nine feet per annum.

1231. You have some experience have you not in embanking lands on the sea at Morecambe Bay?—Yes.

1232. What sort of land are those walls built on?—Altogether, quicksands.

1233. And do you find that they stand?—Perfectly well.

1234. Do you find that they do not sink into the sand?—Not in the least.

1235. You have found that to be a work secure so far?—Yes, there I made eight miles of embankments, and I had no difficulty at all, either in making the embankments or in maintaining them after they were made.

1236. *Chairman.* (To Mr. *Roberts.*) What do you expect to get an acre in extra crops from this irrigated land?—It is based on a return of 20 *l.* per acre for the grass, that is the highest rental that we should expect to get.

1237. Lord *Fermoy.*] In your estimate you take the land at 6 *l.*, do you not?—We have calculated 7 *l.* in our estimate.

1238. That leaves you 13 *l.* an acre to pay the working expenses and interest on capital?—We do not expect to get that 20 *l.* except over a series of years; it will only let for 20 *l.* under very favourable circumstances, when a market is created. The chances are that we might be many years before we get 10 *l.* an acre over the whole surface; it is like every other business, a demand must be created.

1239. Do you propose to let the whole of the land to tenants, or to sell the grass before mowing it?—We propose to take the land on lease, to enter on the land, and fix all the works, to apply our own labour, and then to sell the crops standing. No better system can be adopted than that of letting it by auction, according to the crop that is on the land.

1240. Do you think it possible to get into possession of that 9,000 acres in a reasonable time?—I have not the slightest doubt that if the Board had given us the concession when they almost promised to do so, we should have had it, and had the greater portion of it in working order by this time.

1241. Dr. *Brady.*] (To Mr. *Brunlees.*) How much of this land is under water during the year?—None of it.

1242. Are these not the marshes down in Essex on the right hand side of the present works of the Board of Works?—Yes; but they are kept clear by an embankment, and drained by sluices at low water.

1243. When there are heavy rains, are not those lands submerged?—Partially so, but not to any great extent.

1244. Have you ever travelled by the Eastern Counties Railway?—Yes.

1245. Have you not seen that the water has come up to the railway itself?—No doubt the land is covered occasionally; but we have made provision in the estimate for draining the land properly, and carrying the water off through sluices. The sewage would be of no use whatever to any of that land until the land was properly drained.

1246. And are the expenses attendant upon that drainage included in your calculation?—They are all included.

1247. You state that you put all the sewage of the north portion of the metropolis on this space of 9,000 acres, is that so?—That is so.

1248. Do you think that, from the state of the land at the present time, all that sewage could be put profitably on 9,000 acres?—I think it might, for a time, at all events.

1249. Could you apply it every day in the year?—Not to every portion of the land; it would not be necessary to apply it to every portion of the land every day.

1250. Have you calculated that the daily supply of sewage could be consumed each day as it came?—Yes, I have done that; and by making an application 15 times or 16 times per annum to each portion of land the whole would be absorbed.

1251. (To Mr. *Roberts.*) To how many acres at each time would you apply it?—We took the quantity of feet of sewage that Mr. Bazalgette had calculated his sewers as capable of conveying, and taking those data of 10,000,000 cubic feet a-day. In rough numbers, we find that, deducting for Sundays, on which day there is not the same quantity of sewage produced as on other days, there was, in the course of the year, 294, 542, 218 cubic feet of sewage, which, if divided by nine, which would give a depth of nine feet would cover about 8,403 acres in the year.

1252. Mr. *F. North.*] Is that the depth over the whole of the year?—Yes; nine feet deep.

1253. Dr. *Brady.*] Then you would apply a month's sewage upon one portion of the land?—Quite so. As the plan is laid out each pipe is of such a size as would convey sufficient sewage over a pane of 10 acres in six hours, so that a piece of land would be irrigated in from six to twelve hours, and then, in a general way, we should not require more for it.

1254. *Chairman.*] Over 20,000 acres, it has been stated in evidence, that the sewage of the north side of the metropolis would be seven feet deep; you state that your 9,000 acres would only be covered to a depth of nine feet; can you explain that?—It entirely depends upon what basis of calculation you start from. We took Mr. Bazalgette's Report of May 1856, section 2, following page 26, and there he gives us the total quantity that he calculates the sewers are able to convey. That is the basis of our calculation, but that is without the storm-water.

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1255. (To Mr. *Brunlees.*) It has been stated that 20,000 acres would take seven feet of sewage without the storm-water, and Mr. Roberts has stated that 9,000 acres would only take nine feet, can you explain those statements?—The calculation is taken from a different basis I apprehend.

1256. Will you furnish the Committee with a copy of the calculations which you have made with regard to the disposal of the sewage?—We shall be very happy to furnish those calculations.

1257. Mr. *Sclater-Booth.*] Supposing you made an agreement this summer with the Board of Works, within how short a space of time would you undertake that the sewage should be utilised in the way you propose?—Mr. Brunlees, in addressing me on the 10th of August 1859, suggested that by the spring he could have works in readiness to consume all the sewage that the Board of Works brought down.

1258. That was in the space of nine months?—That was in nine months.

1259. Should you require an Act of Parliament?—We propose for the first 1,000 acres to work without an Act of Parliament.

Jovis, 26° *die Maii*, 1864.

MEMBERS PRESENT:

Mr. Adderley.
Mr. Sclater-Booth.
Dr. Brady.
Mr. Ferrand.
Lord Fermoy.
Mr. Hibbert.
Mr. Leader.
Lord Robert Montagu.
Mr. North.
Sir Joseph Paxton.
Sir William Russell.
Mr. Tite.

LORD ROBERT MONTAGU, IN THE CHAIR.

Sir CHARLES FOX, and RICHARD SMITH, Esq., called in; and Examined.

Sir *C. Fox*, and *R. Smith*, Esq.

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1260. *Chairman.*] YOU sent in a tender, in conjunction with Lord Torrington, to the Board of Works, did you not?—I did.

1261. That was dated the 6th of July 1863, was it not?—It was.

1262. It was a tender for utilising the whole of the sewage of London in a fluid state, was it not?—It was.

1263. In that tender do you state your inability to comply with the conditions of the advertisement put forth by the Board of Works?—Yes; we did.

1264. With regard to the extent of area required, according to that tender, you state your belief that 30,000 or 40,000 acres would be sufficient?—Yes; in the first statement, I think we did.

1265. You also stated that you could not negotiate the purchase of so much land, if the publicity which the advertisement required were given?—We said that that would but impose serious difficulties.

1266. Was that reasonable that you should not comply with the conditions of the advertisement?—Yes; we thought it would hardly be right to expect compulsory purchase for so large an area, and that, therefore, it must be by consent, and we thought that if parties knew that the scheme was projected they would naturally raise their price.

1267. What do you conceive to be the value of the London sewage, so far as the rate-payers are concerned?—I agree with Professor Liebig, in his estimate of the value of the sewage, that it is worth about 1⅓ *d.* per ton, without any artificial fertiliser being added to it.

1268. What profit would you think an adequate remuneration as rent, for 30,000 or 40,000 acres, which you would purchase?—I do not know that I can answer that question now. I think that the value of the land will be most importantly increased by the use of the sewage; but I do not think that anybody can answer that question with any degree of accuracy.

1269. Supposing that you were the possessors of the land, and that it was rented from you, what would you consider to be a proper rent for it?—That would depend entirely upon the land, and upon the amount of fertilising material that was put upon it.

1270. But supposing that you possessed those 30,000 or 40,000 acres, what rent would you think a fair rent to receive, if a person leased it of you?—I have never gone into that calculation at all.

1271. (To Mr. *Smith.*) Will you state what is your profession?—I have been connected with agricultural and general land improvements, and I have acted as a land agent.—(Sir *Charles Fox.*) Allow me to say that Mr. Richard Smith was the land agent for Sir George Carew for many years, and he first called my attention to the subject.

1272. (To Mr. *Smith.*) As the Committee are not aware of the locality of these 30,000 or 40,000 acres, would you give them some idea of the nature of the land, by stating what would be an adequate rent for it at the present time?—Eight shillings an acre.

1273. What do you think would be the annual farming and working expenses of that land?—I calculate the labour at about from 2 *l.* to 2 *l.* 5 *s.* per acre.

1274. And what would be the working expenses of your sewage-works, pumping, and so forth?—The sewage-works to lift the sewage proper, would cost about one-twelfth of a penny per ton of sewage, that is for coals, labour, and oil, exclusive of the plant.

1275. (To Sir *Charles Fox.*) What capital would you expend on the construction of the works?—We estimate that the cost of constructing the works for dealing with what we call the sewage proper, without taking into calculation the storm-water, would be 3,569,000 *l.*; but we consider that to do the thing well, taking all the storm-water, except perhaps once or twice in a year, when there may be a very extraordinary fall of water (we may, in fact, say that, taking the average of years, we should deal with it all), would cost 6,098,000 *l.*

1276. Mr. *North.*] The storm-water is all provided for by the Board of Works, is it not?—No; the Honourable Member will find that there are special weirs provided by them for the overflow of the storm-water; but in special cases we propose to deal with the storm-water also.

1277. *Chairman.*] (To Mr. *Smith.*) What do you propose to expend in the purchase of those 30,000 or 40,000 acres?—We reckon about 8 *l.* an acre.

1278. Then, do you consider that you would recover in extra crops enough to pay the interest on

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on the capital expended on your works, on the purchase of land, on the rent of the land, and on the annual working expenses?—There is no doubt of it, and I may add that I was ready to risk my own interest as far as I was concerned in it.

1279. (To Sir *Charles Fox.*) In your letter of July the 6th 1863, in which you make the tender, you do not mention the particulars as to your mode of distribution nor the locality over which the sewage is to be distributed?—No.

1280. In another letter of the 1st of August 1863, you say, "Should time be granted for making the necessary deposits for Parliament, we will undertake to submit the details of our projected plan for your consideration on or before 26th October 1863"?—Yes, I think we did.

1281. In that letter of October 26th, you use these words, "In pursuance of our letter to you of the 1st of August, we have given careful consideration to the question of the London sewage, and its most advantageous disposal"?—Yes.

1282. Referring to your letter of August the 1st, I see that you did not promise to give a careful consideration to the question of the London sewage, but simply an undertaking to submit the details on that day; is not that the case?—I am now looking to the letter of the 1st of August: it says, "Referring to the letter of the 6th ult. on this subject, addressed to you, and signed by Viscount Torrington, Sir Charles Fox, and Mr. Thornton Hunt, we beg to say, that should time be granted for making the necessary deposits for Parliament, we will undertake to submit the details of our projected plan for your consideration on or before 26th October 1863."

1283. In your letter of October 26th, you use these words: "At the time when we wrote that letter, we fully hoped that we should be able, by the present date, to lay before you the definite details of a plan, complete in every part. With that object, we have closely examined the matter in all its aspects, and the examination has but confirmed the doubt which induced us to delay where others had hastened forward; for we preferred to sacrifice priority of position, if it was to be attained by incompleteness of information, and consequent crudity of arrangement"; was that doubt with regard to the extent of area over which you should place the sewage?—Our difficulty was this, that without the Board of Works felt themselves prepared to enter into a provisional contract with us, it was unwise to go further, in fact, it was almost impossible to get gentlemen of sufficient standing to join us. In looking into the matter, they said, "The moment that the Board of Works are prepared to say that, under certain circumstances, they are quite ready to enter into an agreement with you for the use of the sewage, then we shall be prepared to come forward with sufficient strength, not only to pay you a large deposit as a guarantee for carrying out what we undertake, but we shall join with us men who will be thoroughly satisfactory to the Board."

1284. Was that the doubt which induced you to delay?—Yes.

1285. What fresh information had you obtained as to the value of the sewage, and the proper area over which it was to be distributed, and the mode of distribution, between those two dates?—We had been collecting information during the whole period, and Mr. Smith has collected a great amount of information on the subject, which to me is very satisfactory; I think I might state that the first thing which induced me to look at this matter, was an observation which fell from the Honourable Member for Coventry, some two years ago, I should think. When I asked his opinion, whether the liquid manure of London could be made use of, his reply was this; in this climate, especially for green crops, the quantity of rainfall is not sufficient to produce the largest crops; if you were merely to use ordinary water, by the process of irrigation, you would get much better crops; and if you put fertilising material into that water, that would produce better crops. That was the first thing that made up my mind to go into this matter.

1286. You stated, also, that you had arrived at "distinct practical conclusions" as to the best mode of dealing with the question before you, namely, that the sewage can be remuneratively applied only in a liquid form; was that so?—I think so.—(Mr. *Smith.*) I think it is next to impossible to filter it.

1287. And it would not be remunerative if you could do so?—We should lose the larger portion of the fertilising matter, which is contained in it in a fluid state, in consequence of the great affinity which ammonia has for water.

1288. In this letter of the 24th of October, you proposed to conduct the sewage to 250,000 acres in the counties of Essex, Kent, Surrey, and Berkshire?—Yes.

1289. Then, are you of opinion that 30,000 or 40,000 acres would not be sufficient?—Decidedly so. The fact is, we never changed our position from 240,000 acres for the London sewage. Some friends afterwards thought that a smaller area would be better to start with, but 240,000 acres was the original calculation.

1290. Did you not state in your tenders that 30,000 or 40,000 acres would be sufficient?—That was the first letter we wrote to the Board; that is not a tender.—(Sir *Charles Fox.*) We have an opinion which has been expressed by a Member of Parliament, whose name, perhaps, I need not mention, that 30,000 or 40,000 acres would be enough.

Sir C. Fox was asked, by the Chairman, who that Member was?

1290*. What is that Member's name?—Mr. Caird.

1291. Was that the reason why you stated 30,000 or 40,000 acres in that letter of July the 6th?—Yes.

1292. But you have returned, have you not, to your own opinion, upon which you are very decided, that that would be too small?—Yes; 240,000 acres was the area of land that we took from the commencement, having taken into account the sewage of London as being about 80,000,000 gallons per day.

1293. Do you propose to purchase the lands or to obtain them on lease?—We propose to purchase where we can make advantageous purchases, and in other cases to lease. There are many cases where you cannot purchase lands where you can lease them.

1294. Do you think it will be easy to purchase or lease 240,000 acres of land near London?—There would be no difficulty in meeting with lands of sufficient area which we could reach.

1295. Do you propose to cultivate this area yourselves?—Yes; I consider it is quite out of the question to carry out the system proposed by others, namely, of laying mains through a district and then trusting to the farmers to take it by

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by meter. I think that would very likely leave us in this position: that we should have the sewage to deal with, and people would not be prepared to take it. I think that the parties who take the sewage ought to have the control of sufficient land to use it.

1296. In fact you think you ought not to be dependent upon the farmers to do it?—Farmers are slow to perceive the benefit of any new thing; there are many cases in London where there are open sewers through land, and the sewage passing through those ditches is of a highly fertilising kind, but they will not use it.

1296*. Do you propose, then, to cultivate the land yourselves?—Yes.

1297. What capital must you have to stock it?—The Lands Improvement Company and the General Lands Improvements Company are ready to provide for all the main expenditure, and ready to treat with us.

1298. But what amount would be necessary?—Upon the small area, I think, that we gave 3,569,000 *l.*

1299. What is the capital that would be necessary to stock those 250,000 acres which you propose to cultivate?—£. 6,898,678, that is, to stock it, and provide the outlay for distribution.

1300. Does that include the working expenses?—The distribution, without the working expenses.

1301. And what would be the working expenses in addition to that?—The working expenses would be about 2 *l.* 5 *s.* per acre.

1302. You state, in your letter, that to supply sewage to farmers would lead to complication, and most probably to frequent litigation; in what way do you mean?—In the first place, it would be difficult to persuade them that they ought to use it; if they were persuaded, and went to the necessary expense of laying on the distributing apparatus, and were not regularly supplied, we think that there would be constant quarrels and litigation, whereas, if it were in our own hands, we would deal with it as we thought fit. We, perhaps, sometimes could not supply the quantity, but, at other times, we should desire to supply more.

1303. (To Mr. *Smith.*) Can you state what would be your annual expenditure in labour?—£.540,000 is our annual expenditure in labour.

1304. To reach an area of 250,000 acres of arable or grass land, would not your works have to extend over a far larger number of acres, and would you not have to make allowance for roads, villages, and water?—Of course. We calculate on cultivating 240,000 acres.

1305. What would be the whole area over which your works would extend; would it be 500,000 acres?—Nothing like that; I should say under 300,000 acres.

1306. That would increase the amount of expense for leasing and also the working expenses; have you taken that into account in the figures which you have given?—Yes, the gross area of 250,000 acres would mainly distribute it.

1307. Does that include roads?—We should not have many roads; I think we should lay down railways, that would facilitate it. There would be large fields occupying large areas.

1308. Do you mean you have in view a piece of land of that size, without roads, villages, and water?—There are roads and villages, but I have no doubt we can have 50,000 or 60,000 acres within 25 miles of London.

1309. You state, that you are going to cultivate 240,000 acres; over how many acres will your works be extended?—Something like 280,000 or 300,000 acres.

1310. (To Sir *Charles Fox.*) Do you propose to pump by steam?—Yes.

1311. What would be the horse-power that you would require?—Three thousand five hundred nominal horse-power.

1312. Do you assume the sewage to be 80,000,000 gallons daily?—Yes.

1313. That would be 132,727,272·7 tons per annum, would it not?—Yes.—(Mr. *Smith.*) The sewage proper will take 4,702 horse-power to lift it 180 feet; that is, allowing for friction, and for dealing with the gross sewage, it will take 19,096 horse-power.—(Sir *Charles Fox.*) That is Watts's horse-power of 33,000 lbs. lifted.

1314. You propose to apply the sewage chiefly by jets, do you not?—Yes.

1315. Mr. *Smith.*] How many detached reservoirs do you propose to have on that area of land?—It would depend upon the position of the land entirely; where we found great altitudes, we should pump to the detached reservoirs, and then supply the sewage from those detached reservoirs by gravitation.

1316. Then you would have separate pumping to each detached reservoir?—Decidedly.

1317. Have you surveyed the land yet?—We have had it examined.

1318. Do you know where these detached reservoirs would be situated?—We cannot define them at present.

1319. Would they be covered reservoirs?—Of course.

1320. But would the covering be water-proof?—Yes.

1321. You pump up into the reservoirs separately; it does not flow in from pressure from the summit reservoir, does it?—No; we calculate that it will be 180 feet; as far as we could distribute by gravitation we should, and then, when we get it to the higher levels, we should pump it from there.—(Sir *Charles Fox.*) From our main reservoir, we should pump into the others, and we should have subsidiary engines. We have taken 180 feet as the average height to which the whole of the sewage of London will have to be lifted; that is, of course, too much for some cases, and too little for others; but, on an average, we think that it will meet the whole case.

1322. But have you included with that horse-power the subsidiary engines?—Yes; that amount of horse-power deals with the whole quantity.—(Mr. *Smith.*) £.1 an acre is allowed for additional horse-power in the calculation for the stocking of the farms.

1323. How many distributing mains per square mile would you require?—We take 11 mains to pass the 30 miles, but we cannot give it exactly at present.

1324. Do you mean, that you would require only one mile of main for three square miles of country?—I think we might not require more than that.—(Sir *Charles Fox.*) By mains, we mean very large pipes of three feet six inches, or four feet six inches in diameter.

1325. Would they be about four feet on an average?—From three feet six inches to four feet six inches.

1326. Is there any calculation in your estimate as to the quantity and cost of the piping which you would require?—It would be 443,520 *l.* for the sewage proper.

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1327. (To Sir *Charles Fox.*) Could you give the amount per acre, or per square mile, that you would require?—We will prepare a paper, and lay it before the Committee in a day or two, with all this information.

1328. What would be the cost of the iron pipes per ton?—I consider that the iron pipes can be purchased on the Thames at 4 *l.* 10 *s.* per ton, and, to convey them to their destination, will cost about another 1 *l.*

1329. What would be the cost of the iron pipes per square mile?—The distribution will not be by means of iron pipes, but by earthenware pipes; these pipes are the mains for conveying the bulk of the sewage to the district.

1330. Do you think that these earthenware pipes will stand the pressure?—There is scarcely any pressure to stand; we can find earthenware pipes to stand 200 lbs. to the inch.

1331. (To Mr. *Smith.*) Towards the bottom of the earthenware pipes, must there not be a great amount of pressure if you have the hose and jet system of distribution?—We do not contemplate always distributing the sewage by a hose and jet, but by portable engines where necessary.

1332. Does the sewage fall by gravitation from those reservoirs on the altitudes which you have mentioned?—Yes; I think, that whenever we have obtained an altitude, it will be better to deliver it by hose pipes attached to those mains. We have had some experiments made, and we find that almost all drainpipes will bear a column of 100 feet of water, and some of them, which are made in the neighbourhood of Glasgow, particularly, where they are vitrified, will bear a great deal more than that.

1333. When the sewage falls down by gravitation, there will be a certain internal pressure on the pipe, will there not, when the sewage comes out of the jet?—Yes.

1334. Where does it flow to out of the reservoir?—It flows into a portable engine for spreading upon the land.

1335. Does the engine pump the sewage out?—The engine pumps it.

1336. What does it pump it out of?—It pumps it out of the mains.

1337. Lord *Fermoy.*] It is on the same principle as a fire engine, is it not?—Yes; if you take the steam fire engine you have it as nearly as possible.—(Sir *Charles Fox.*) We should like all the mains to be of earthenware, because they will not be acted upon as iron is acted upon; for any pipe, not larger than 18 inches in diameter, earthenware will bear any pressure.

1338. *Chairman.*] (To Mr. *Smith.*) How many miles of earthenware piping would you require?—We calculate that we should want 1,309 miles of earthenware piping in addition to the mains; those are, in fact, the distributing pipes: that is, taking 15 yards to the acre.

1339. How much lead per mile would you require for jointing those large iron mains?—I will make a calculation of that, and lay it before the Committee on a future occasion.

1340. How much will it cost per mile to lay the mains?—We calculate that at 10 *s.* a yard.

1341. How much will it cost to lay the earthenware pipes, or distributing pipes?—We estimate that at 4 *s.* a yard.

1342. (To Sir *Charles Fox.*) Those pipes are to be laid along the roads and railways, are they not?—They are, where it is practicable to do so.

1343. You refer to the distributing pipes, and not to the iron mains?—I mean the iron mains; the others will be laid about the land.—(Mr. *Smith.*) I think that, with the iron mains, we shall follow as much as we can the course of the rivers and canals, and, if an accident happens, then we have an escape by letting the sewage into the rivers or canals, without doing any damage.

1344. Why do you not confine yourself to roads, instead of roads and railways; because it would seem that a railway does not go to every farm, whereas every farm must have a road of some kind to it?—The railways would pass through the main portion of the particular lands that we have in view.—(Sir *Charles Fox.*) Our object would be to get the large iron mains as short as possible, and therefore to go by the most direct roads. The question of distribution over the area is very little affected by the distribution of the main; it would matter very little where the large main was; you would have to distribute from one side to the other, and it would only affect the diameter of a few of the pipes.

1345. If it went across diagonally, in many cases would it not make a difference in the length of the main?—Not in the length of the distributing pipes, because we take the power to irrigate on every acre of land.

1346. Would there be no difference in that case as to the length of the iron main?—No. Supposing that we have to go a distance of 30 miles, of course it would be to our advantage to go as the crow flies, but that is a comparatively unimportant matter; the distributing pipes must go out of the mains, and it is only a question of diameter.

1347. It would be your object, would it not, to have as short a main as possible?—No doubt.

1348. As to your mode of distribution; you state that you take the sewage through earthenware pipes; do you have hydrants over the farm to which you would attach a hose and jet?—Yes, most likely we should.

1349. And you would turn a cock to let the sewage on?—Yes; we should have pipes to different points on the farm; but, as to the details, we have not yet settled them.

1350. To Mr. *Smith.*] For that purpose, you must have a pressure, must you not?—To get it to the pipes, we must, but we do not want pressure for the distribution, because we apply our suction-pipe to the hydrant, and get it from the engine.

1351. Sir Charles Fox has stated, that, in some instances, he would have a hose and jet, and that he preferred that; what is your opinion upon that subject?—I say, that whenever our reservoir has sufficient altitude to play a jet of sewage, I should certainly make use of it; I should not go to the second expense of hand-power in our pumping engine, when other power was already available.

1352. If you have a hose and jet, you must have pressure, must you not?—No doubt.

1353. To Sir *Charles Fox.*] You stated, that these earthenware pipes will bear a column of 100 feet of water?—I said, that they would bear that with perfect safety; some will bear a great deal more; some have borne 300 lbs. to the inch; of course, we should not pump water 100 feet higher than was necessary.—(Mr. *Smith.*) In this instance, we should work by catch-water irrigation, and work it twice over.

1354. Would you lay your mains underground

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to protect them from the frost?—Yes; at a depth of three feet.

1355. Would the mains undulate with the face of the country?—They would undulate to a certain extent; we should try by every means to avoid undulations, but where they are necessary, we must put up with them. In carrying water about a town, we are obliged to go up and down, following the contour of the town.

1356. (To Sir *Charles Fox.*) Then would there not be a great variation in the internal pressure in the pipes?—There would be a constant variation. The great mains starting from London, where they would have the greatest pressure, in all probability, would be thicker in metal than those at the higher elevation; that is a matter so completely known in public works that there would be no difficulty about it.

1357. You state, that you pump into each separate district reservoir; do you pump out of a tank, or out of a well, or out of the main itself?—In the first instance, we should pump from seven pumping stations in London itself; we shall have small tanks into which the sewage will flow, and from those tanks we shall pump.

1358. But when you have got it out into the country and want to get it into your district reservoirs, how shall you proceed with it?—We shall pump it from a small reservoir.

1359. Then, have you two reservoirs, one low and one high; do you pump from a well into the reservoir?—Yes; in that sense we should; there would be a small aperture in the bottom of the tank as a well-hole for the suction pipe.

1360. Following the sewage along through a main, you approach one of those reservoirs, where does the sewage go to?—The sewage that has not been taken off from the main, as it passes along, will go into the reservoir at the end.

1361. How does it get into the reservoir at the end?—From the end of the main.

1362. Did you not state that you pumped it in?—We pump at the lower end of the main.

1363. Then it goes in by pressure, does it not?—It has to be lifted by steam power, and whatever quantity of sewage is over and above the quantity, which is used by the land *in transitu* will go into the reservoir.

1364. Then, if I understand rightly, the pumping is not at each reservoir, but is at the beginning of the main?—At the pumping stations in London and at the two outfalls.

1365. After you have pumped it, does it flow down by gravitation through the mains?—No; the greater part of the lands would be above the elevation of London, and the pumping stations of London will pump it through the large mains on to those lands, and on those lands we mean to have a reservoir to take any quantity that may not have been taken out of the main *in transitu*.

1366. Would there not be great danger, from the great pressure against the engines, of their breaking down?—I do not see that there is any more danger in pumping sewage than in pumping water. In one room, in some waterworks which I constructed at Berlin, we have six engines pumping 180 feet, and I think that the largest main there is 36 inches. I laid down 134 miles of main in that city, and the service being high service, we pump over a stand pipe, which, I think, is 180 feet high.

1367. You have no stand pipe in this case, have you?—Whether we have a stand pipe or an air vessel matters very little.

1368. But if the sewage goes over a stand pipe it goes by gravitation, does it not?—Of course.

1369. But you state that you force it all the way?—I think that is a better plan.

1370. You would force it?—Not over a standpipe; I should have an air vessel close to the pump; so that when the reciprocating action would let the sewage in the main stop, I should keep up the velocity in the mains.

1371. You would force it the whole way over the 250,000 acres?—Yes; exactly as we do for the supply of a town. In the case of the supply of Liverpool, the water comes from a place called Rivington Pike, which is at the high level, and flows down into the streets of Liverpool, and all the mains, except in the higher parts of the town, are under the pressure of a column of 100 feet of water.

1372. Mr. *Tite.*] Is it not the same at Leeds?—It is the same at Leeds, and at Manchester too.

1373. *Chairman.*] When you proposed to deal with the sewage of so great a metropolis as London, had you matured all the details of the plan?—We have not yet; we have never considered ourselves in a position to go to that expense.

1374. Have you gone into the details at all?—We have gone into the details to make sure that our capital would be quite sufficient for the purpose.

1375. You speak of "some modifications being found necessary" in your plan; have you any doubt about the details of the plan?—I have never had any doubt about it.

1376. (To Mr. *Smith.*) In your letter of the 26th October, you say, that your system will be "subject to such modifications as might hereafter be found necessary"; what is the reason of that?—That was only a safety clause, supposing that some of our calculations might not be found correct; we mean that as a reserve merely with regard to actual figures.

1377. (To Sir *Charles Fox.*) You state also, in this letter, that you propose "to erect at the seven stations marked on the plan sent herewith, and at others, if necessary, steam-pumping engines of, say, a total of 3,500 horse-power, capable of being doubled if required"; have you any doubt as to the amount of engine-power that would be found necessary?—I do not think that at that time anybody had made up his mind as to the quantity to be pumped; there were very great differences of opinion at that time; that was at a very early stage of the investigation.

1378. On the 26th October 1863, was there any doubt as to the quantity of sewage to be dealt with?—There was, at all events, a very great difference of opinion up to the end of last year.

1379. Is there some doubt about it now?—There is some doubt now.

1380. (To Mr. *Smith.*) There is some doubt, is there, as to the amount of steam power that will be necessary?—We have increased our power since that time, and we now say, that steam power will be required to lift it 180 feet. We did not at first calculate upon lifting it to so great an altitude, and it increases our horse-power to 4,702 horse-power for the sewage proper; but taking it with the storm water, and leaving three engines in reserve, it will be increased to 19,096 net horse-power. (Sir *Charles Fox.*) In the earliest stages of

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of the investigation of this matter, it was considered that the storm-water would not have a large proportion of fertilising matter in it; but, by the analyses which were made by various chemists, it was found that the storm-water is as valuable as the ordinary sewage, and that is accounted for in this way: between the storms, a great deal of solid matter accumulates in the bottom of the sewers, and then, when a heavy storm comes, that gets washed away, so that the total quantity of matter in suspension in the storm-water is rather greater than that which is in the ordinary sewage of every day.

1381. In this letter you state, that part of your system is "to receive the ordinary sewage from the main sewers at these stations and to pump it thence through seven cast-iron mains, of three feet in diameter each, laid along the banks of the river, as shown on the plan, with provisions for interchange between the mains in case of accidents"; have you now increased the mains?—Yes; they are from 3 feet 6 inches to 4 feet 6 inches in diameter; that is, taking the storm-water for the sewage proper.

1382. (To Mr. *Smith.*) You proceed to say, that you propose "to erect at each of the pumping stations two covered settling tanks to receive the deposit of all heavy and insoluble matter intermingled with the sewage; one of these tanks to be in use whilst the other is being cleansed; this process being performed each morning before 8 A. M.; the solid matter thus deposited to be removed by water to suitable lands"; is that the case?—Yes.

1383. Further on, you say, that you propose "to allow the storm-water to pass over weirs at the pumping stations down the main sewers to the main reservoirs provided by the Board, and thence to pump it through mains on to suitable lands on either side of the river"; are you to have seven pumping stations along the line of the mains, besides the other pumping stations that you speak of?—Those are the two outfall mains provided by the Board of Works.

1384. Are you not to have any other pumping stations than those near the reservoirs which you spoke of?—At each station there will be two settling tanks.

1385. Then, have you 14 tanks?—We have 14 tanks.

1386. Of what dimensions are those tanks?—About half an acre each.

1387. Would they be covered?—They would be covered.

1388. Do you propose to ventilate them in any way?—We propose to ventilate them.—(Sir *Charles Fox.*) We have had a great deal of consideration upon the question of ventilation, and we have quite decided that it must be done, but we have not yet decided the best mode of doing it.

1389. (To Mr. *Smith.*) How do you propose that the sewage should settle in those tanks which you call settling tanks?—It would not require any settling, except with regard to the silicious and iron portion of the sewage, and that would settle down in a few seconds.—(Sir *Charles Fox.*) The moment a stream of water having passed at a high velocity comes into a wider vessel, its velocity is diminished even though it is still passing. Take, for instance, a pipe of a foot in diameter, and let that end in a tube of two feet in diameter, the velocity will be reduced as the square of the diameter, and that would let it settle.

1390. Would this settling tank be lower than the main that feeds it?—It would be a little lower.

1391. How much lower would it be?—Three feet, I should think. Those tanks are half an acre each in area, and there would be half an acre at each of those stations for the subsidence of one day's sewage due to that one station.

1392. Do you pump the sewage out of those settling tanks by steam?—Yes.

1393. (To Mr. *Smith.*) How do you propose to do that; will the suction pipe proceed from the top of the tank?—There would be a well outside the tank; the tank must be a settling tank, and then the water where the solid matter was settled would flow over the weir of the higher portion of that tank into a well; and then we should pump from the well.—(Sir *Charles Fox.*) Though it is called a well, it is in fact a reservoir at a little increased depth, so that the suction pipe from our engines shall be always well covered with water.

1394. Is it a well that you pump from, and not from the tank?—They will not be deep holes into the ground, but small tanks deeper than the main one.

1395. You will only pump the sewage during ten working hours?—We shall pump the sewage day and night.

1396. Will you pump it out of this well day and night?—Yes.

1397. Then will it flow on to the land day and night?—It will be either flowing on to the land or going into our reception reservoirs. We propose to empty the reception reservoirs during the day.

1398. Are those reception reservoirs something different from the settling tanks?—They are at the ends of the mains. I said, that the sewage that might be taken off from the mains *in transitu* would be collected in tanks at their extremities; we should take care to keep those tanks so as to get them empty by night.

1399. Is that before or after the sewage gets to the collecting tanks?—After.

1400. Then the reception reservoirs will be in the country, will they not?—The sewers of London will run into the settling tanks in which the more solid part of the manure will be deposited; all of those mains are three feet six inches or four feet six inches in diameter, and at their extremities there will be other tanks.

1401. Is that besides the 14 tanks which you have already mentioned?—Just so.

1402. Beyond those tanks, how will you manage the distribution?—Where circumstances will admit of it, we shall certainly do it by gravitation; and, where they will not admit of it, we shall then have to use those hand-pumping engines on the farms that Mr. Smith has spoken of.

1403. (To Mr. *Smith.*) You have stated, have you not, that the flow of the sewage was 80,000,000 gallons a day?—It is 81,250,000 gallons, according to Dr. Frankland's estimate.

1404. And you will require a horse-power of 3,500?—Four thousand seven hundred and two net horse-power.

1405. How high would an engine of such a horse-power pump that quantity of sewage in ten hours?—We calculate that we get an equilibrium from the reservoir, so that our flow would be constant.

1406. My question was this; how high would that amount of horse-power pump that amount of sewage in 10 hours?—We do not calculate

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upon 10 hours, we calculate that the reservoirs will give us an equilibrium; we pump all night, and get a constant supply. The Board of Works contemplates pumping all night.

1407. You propose to construct, as filters, from 500 to 1,000 acres of osier beds, through which you will pass the sewage after it has left the other lands, in order fully to deprive it of all deleterious and injurious matters; are you uncertain as to the size of those osier beds?—The London Water Works allow two square yards for a gallon of water per minute, and I think we have more than 10 square yards per minute.

1408. You state that you will construct from 500 to 1,000 acres of osier beds; are you uncertain as to the exact amount of land that you require?—I think that we have provided for ample powers.

1409. But why do you say "from 500 acres to 1,000 acres"; why do you not say 600 or 700 acres?—If we take the sewage proper, we take 500 acres; if we took the gross sewage, and the rainfall, and the storm overflow, we should propose to take 1,000 acres.—(Sir *Charles Fox.*) The water that is used for the purposes of irrigation and fertilisation must in a great measure find its way back again into the river; but our object is to rid it of all the fertilising properties, and after it has been applied to the land to make use of it again, in the growth of osiers; that is a very profitable operation, and it will take the last fertilising properties out of the water.

1410. (To Mr. *Smith.*) Has the osier any peculiar property of deodorising the water?—We always find osiers precipitating to a great depth in search of water, and if you have a sewer, or a drain, it is almost sure to be filled with roots of willows or osiers.

1411. Then, it is not peculiarly valuable as a deodorant?—Its peculiar value is, that it grows in water. The alder would be equally as good as the osier.—(Sir *Charles Fox*). The osier is of unusually rapid growth, and, consequently, requires more fertilisation.

1412. (To Mr. *Smith*). How many osier beds do you contemplate having over the whole area?—We propose having from 500 to 1,000 acres.

1413. Could you not state what the size of each bed would be?—That would depend entirely on the circumstances, and on the area that they drained.

1414. You could not state the distance which they would be from one another?—Not precisely. We should construct the osier beds in all the lower levels.

1415. But after you have spread this sewage over the 250,000 acres, how are you to catch it again, and get it into the osier beds?—By gravitation. It would be at a high altitude, and then it would flow into the osier beds, so that all our drainage flows through the osier beds before it enters the river.—(Sir *Charles Fox*). As far as possible, we should desire that all the water which has already been used for fertilising the land, should be collected and thrown into those osier beds.

1416. (To Mr. *Smith.*) In frost, the sewage does not sink into the land, does it?—I think it will. The temperature of the sewage, according to Mr. Mechi, is quite high enough to thaw a hard frost sufficiently to soften it.—(Sir *Charles Fox.*) I thought that the sewage would find its way back to the Thames, but Mr. Mechi thinks not, and Mr. Smith agrees with him.

1417. (To Mr. *Smith*). Supposing that it does not sink into the land, it would all run down to the osier beds, would it not?—It would all run down on to the embanked meadows, and then to the osier beds, so that it would be twice filtered.

1418. In that case, would you not have 80,000,000 gallons on your osier beds?—We should always have 80,000,000 gallons; it passes through our land first, and then goes to our osier beds; but we propose to construct artificial filtering beds on our fallow lands, to the extent of from 500 to 1,000 acres, to pass it through first, so as to take out all the larger amount of fertilising matter, and retain it for manure.

1419. Do you wish to let it run over fallow ground merely?—No; we construct 500 acres of artificial filter beds on the fallows.

1420. How would those filter beds be constructed?—They will be constructed of the refuse of vegetable matter collected on the lands, and then applied with gypsum, or burnt clay, in layers, so as to make the filtering matter, and then it will be passed on to the osier beds.

1421. (To Sir *Charles Fox.*) In warm weather the sewage sinks into the ground, but in cold weather it will flow into the osier beds; is that so?—Mr. Mechi says not; but that the temperature of the sewage, as taken at once, will melt the surface.

1422. If it does not sink in it will flow into the osier beds, and if it overflows the osier beds it will flow into the Thames?—Yes.

1423. In a letter, written by you on the 7th November 1863, to the Board of Works, you say that you are willing to bind yourselves under a penalty of 10*l.* per hour for every hour during which the storm-water shall be allowed to flow into the Thames?—We are quite willing to abide by that.

1424. The sewage, of course, you would apply in such a way as to increase, as far as possible, the quantity of food that would be grown throughout the country?—No doubt; and I think that one very important point connected with it is this: that, at first, it was considered that all the manufacturers of artificial manure would be against the utilisation of the sewage of towns; but I think that Baron Liebig has quite settled that question, because he says that, even with the sewage of London, we might purchase, and mix with it, all the artificial manure which is made in England, with immense profit to the parties who enter into this project. He states, as an absolute certainty, that, by mixing artificial manure with sewage, the value of the sewage may be increased from 1½*d.* to 4*d.* per ton, with advantage to everybody, and that, therefore, the artificial manure people ought to be our best friends.

1425. You would do that before you sent it into the country?—Yes.

1426. In this letter of the 26th of October you state, that "the object which you have in view is the freeing of the River Thames from the obnoxious and poisonous matters that now infest it"; is that your object?—That is one of the objects; the first object is to prevent the sewage of London from flowing into the River Thames as a question of health to the City of London, and the next is to turn it to profitable account, and that we believe we can do.

1427. In your letter of the 31st March of this year, you propose to allow all the sewage which you do not put upon the land to flow into the Thames?—

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Thames?—Yes, that was to meet the wishes of the Board of Works; that was when a proposition was made to pay for the sewage upon the principle of a royalty, because this difficulty was raised, that we might enter into an arrangement with the Board of Works (which might be a failure) only to deal with a certain portion, whereas if they entered into arrangement to give it all to us they might be precluded from treating with other parties.

1428. Did you not state that you would be bound by your previous proposal as to the penalty of 10 *l.* per hour?—That is assuming that we entered into an arrangement with the Commissioners to take it all. We are quite prepared to take it all, subject to that penalty, but if we were to take it upon the principle of taking it at a royalty, and paying so much a ton, and leaving them to dispose of it to anybody else, then we should only be responsible for the part that we took and paid the royalty upon.

1429. But are you to be bound in a penalty of 10 *l.* an hour, and yet to take such a portion as you can employ profitably, and allow the rest to flow into the Thames?—The two cases are unlike one another. In the one case we are to take it all, and in that event we are to be subject to a penalty of 10 *l.* an hour if we let any of the storm-overflow go into the Thames. In the other case we are to take only so much, and to pay a royalty upon the sewage.

1430. Then, which is the proposal which you now make?—We are prepared to deal with any of them; but we should prefer to take the whole of the sewage, in which case we should be under the penalty of 10 *l.* an hour.

1431. (To Mr. *Smith.*) What is the rent which you propose to give for the sewage?—£. 10,000 a-year, according to the last letter; that is for as much as we can employ profitably.

1432. Is that for the whole?—That is for the whole.

1433. (To Sir *Charles Fox.*) You state in that same letter of the 31st March 1864, that you do propose to allow all the sewage that you do not employ to flow into the Thames; will you explain that?—That was upon the assumption that we were to pay a royalty.

1434. Is that for a portion, or for the whole?—For the whole. What I understood was, that if the Commissioners chose to have the power of making an arrangement with more than one party, they were to go on the principle of a royalty, and that that 10 *l.* penalty is only to apply in the event of our binding ourselves to take the whole of the sewage.

1435. In that case, how much would you pay?—£. 10 an hour for every hour during which the storm-water is allowed to flow into the Thames.

1436. And what rent would you pay for the sewage in that case?—That has never been settled. We offered the Board of Works a dividend of 2 per cent. upon the capital after the shareholders had received a dividend of 7½ per cent.—(Sir *Charles Fox.*) The question of the royalty per ton has never been settled at all; it was a suggestion thrown out at that meeting which we said we should be willing to consider; but this letter contemplates two events, one of which is our being bound in case any of the sewage flowed into the Thames, in a penalty of 10 *l.* per hour, and in that case we mentioned no price. In the other case, if they let us the whole of the sewage, we pay them 10,000 *l.* a-year.

1437. If you take the whole sewage you are not to let it flow into the Thames, except under that penalty?—Yes, exactly.

1438. But have you not put the two things (the penalty and the rent of 10,000 *l.*) together in your letter without separating them?—I think this letter is improperly drawn.

1439. But you have signed it in company with Lord Torrington, Mr. Thornton Hunt, and Mr. Smith, have you not?—Yes; I do not see how it was possible that we could contemplate paying 10 *l.* per hour if we were every day going to let the sewage flow into the Thames.—(Mr. *Smith.*) We had three distinct tenders before the Board of Works; in the first we offered to take the whole of the sewage, and to pay the Board of Works 2 per cent., after paying 7½ per cent. to the shareholders; in that instance we guaranteed to take the whole of the sewage, and to pay a penalty of 10 *l.* per hour for every hour during which we allowed the safety-valves to be open. We also made a tender to deodorise the sewage, provided the Board of Works would pay half the expense of that deodorisation.

1440. In either of those cases the Board was to provide land for pumping stations and deodorising works, was it not?—Yes; and then the Board of Works asked for a fixed royalty. We said we would give them 10,000 *l.* a-year for a fixed royalty to take the whole of the sewage, and to apply as much of it as we can employ profitably, allowing the remainder to flow into the Thames.

1441. Mr. *Tite.*] (To Sir *Charles Fox.*) Do you or do you not imagine that any scheme for utilising the sewage of the metropolis must provide for an overflow into the River Thames in any circumstances in case of storms?—I think that very likely two days in the year there would be an overflow into the Thames.

1442. Then would not the fertilising matter of the sewage be in great dilution?—In ordinary storm-water the quantity of fertilising matter in the water is rather larger than, under ordinary circumstances, from the fact of the water washing out the deposit from the bottom of the sewers. It so happens that the first portion of the storm-water washes out the greater portion of accumulation in the sewers, and that would pass away on to the lands, and it would only be the latter portions of the storm-water which are very much free from injurious matter, which would go into the River Thames, and that only during some of the summer storms.

1443. You contemplate that that may happen four times in the year?—Yes; and if it does we are to pay a penalty of 10 *l.* an hour while it lasts.

1444. There was a clause in your original tender to the effect that the Board of Works should guarantee you against the consequences of any nuisance that might be created, and at the meeting in February you stated that you thought that such a clause ought to be introduced; is that abandoned, or is it not?—I am quite of opinion that it ought to be.

1445. Do you imagine that that difficulty would ever arise?—No; I do not apprehend that it would.—(Mr. *Smith.*) I think it is contemplated by our legal advisers to take powers in the Act to guarantee us against that, and consequently the Board would be guaranteed also.

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1446. That was a subsequent suggestion to the description in February, was it not?—Yes.

1447. (To Sir *Charles Fox.*) Then, did I understand you to state, in answer to a question put to you by the noble Chairman, that your proposition for a royalty contemplated taking the whole of the sewage, and paying 10,000 *l.* a-year for it?—We are quite prepared to pay 10,000 *l.* a-year if the Board of Works give us the whole of the sewage; but if, on the contrary, the Board of Works wish to have the power to let portions of the sewage to other parties, then we are prepared to take a good portion of it on the payment of a royalty.

1448. And you would pay in proportion?—We should pay in proportion.

1449. (To Mr. *Smith.*) The royalty contemplated your finding land and everything else, and it was upon that condition that you were asked to consider it; is that so now?—The pumping stations so far as the Board of Works have control, we anticipate their finding, but they have not to purchase anything.

1450. Then your offer is to take the whole arrangement of the matter in such a way as the Board of Works can give it to you, they affording you every facility that you could reasonably ask for them, and you taking the whole thing off their hands, and assuming the whole of the responsibility; is that so?—Entirely so.

1451. Dr. *Brady.*] Did I rightly understand you to state, that you had great facilities in gaining possession of the lands?—Yes.

1452. Have you any objection to state where those lands are that will be so easily obtained?—Of course, if the Committee desire it, I am bound to state it; but I think I might be stating matters which might be injurious to the company.

1453. Are not the lands within a circumference of 25 miles of London, generally employed now as market gardens?—No, nor within 10 miles.

1454. How far is Fulham from London?—I am not certain how far it is; there may be certain portions.

1455. How far is Bermondsey from London?—Bermondsey comes within a mile and a half of St. Paul's.—(Sir *Charles Fox.*) I think it would be only right to say, that as regards the question of nuisance, we do not take any lands within six miles of St. Paul's Cathedral.

1456. (To Mr. *Smith.*) Did you state that the Lands Improvement Company would advance you the necessary capital for your scheme?—It would advance us certain proportions; I have arranged with two parties, one of whom is to supply us with from 300,000 *l.* to 500,000 *l.*, and the other with 1,000,000 *l.* if we want it.

1457. You were present the other day at a meeting of the Committee, and heard a gentlemen give evidence with regard to Messrs. Napier and Hope's plan, did you not?—I did.

1458. Did not that gentleman state that that society was prepared to advance capital for that scheme?—There are three societies; there is the Lands Improvement Company, and the General Lands Improvement Company; one of them is the same which Mr. Hope spoke of, and the other is not the same.

1459. (To Sir *Charles Fox.*) Then, are those companies prepared to advance the capital to you?—No doubt; there would be no difficulty in raising that portion of the capital that would be expended on the land.

1460. You stated that one of the reasons why you would have a clause guaranteeing you against the consequences of any nuisances, was that you were afraid of litigation with the farmers on account of your not being able to supply them regularly with the sewage that is pumped; has that modified your plan?—That was in the event of our carrying mains along the public roads and selling the sewage by meter to the different occupiers, and that, we think, will not be a good plan.

1461. How will the litigation arise if you had the whole of the sewage under your own direction?—We should not have the command of it unless we had the land to put the sewage upon.

1462. If you made a contract with a number of farmers, how could the litigation arise; are not gas and water companies at the present moment liable to the same objection?—Yes; and they have litigation in consequence.

1463. Then, is it necessary to the undertaking that there should be litigation?—No, I think not; I think, that, by our being the owners or the tenants of the lands on which the sewage is used, that difficulty will not arise at all.

1464. If it were your own land, would you not be losers in case you could not supply sewage to your land?—Yes, and we should have to put up with the loss; it would only be a temporary thing; but, still, there are a great many people who are not disinclined to have a bit of law if they can get it. In many cases we might make arrangements with a farmer to take a certain quantity of sewage which he would find himself unable to take, and then we should have a cause of complaining.

1465. Was it not stated that it was intended to pass the excess of the sewage into the rivers and canals?—Mr. Smith, by the answer which the honourable Member is referring to, meant that if a main should accidentally burst, instead of injuring the railway or the road, its contents should pass into the river or canal, but that would only be while telegraphic communication could pass from one part of the works to another.

1466. Those osier beds would only be supplied from the overflow of the sewage from the high lands, would they?—It would be the sewage that passed through the drains of the lands. One of the greatest difficulties, that all the people who are proposing to distribute the sewage to the farmers and to the tenants will find, is that there is at least 8 *l.* per acre on an average to be expended, either by the landowner or by the tenant farmer, for their distributing pipes and for drainage; and after the sewage has filtered for at least three feet six inches through our land, it will go to our drains and pass on to the lower levels, and after it has done that, it will pass through our osier beds for a second filtration.

1467. But would you, as a practical farmer, contemplate soaking land three feet six inches deep with sewage?—I would saturate it four feet deep if I could get it.

1468. Will you state how many inches the roots of grass and wheat, for instance, pass into the ground?—Turnips and carrots, and various grain crops, will go three feet at least; wheat has been known to go more than three feet. I think, if you will refer to Le Couteur, he will tell you so.—(Sir *Charles Fox.*) We contemplate laying our mains three feet below the surface; I referred before to the case of Berlin; we were instructed there to lay the mains at a depth of three feet; I objected to it at the time, and we had to take many of them up, and lay them down again at a depth of four feet.

1469. (To Mr. *Smith.*) Along the River Thames, or in the neighbourhood of London, do you think that you would have a chance of getting land that you could drain to a depth of four feet, with a fall?—I think, in a few years time, that we shall be able to show that we can drain the Thames Basin to a very much greater depth than is anticipated at present.

1470. You state, do you not, that the overflow after a storm has very much more fertilising matter than the sewage has in ordinary circumstances?—Yes, so the chemists say; but I am not a chemist, and I have not looked into it myself.

1471. Under those circumstances, do you not think that it is advisable that all the storm water should be provided for?—Yes, I have said so. If you have a very extreme amount occasionally, perhaps the farmers will not take it, and it must go into the Thames for a few hours.

1472. Then you have not contemplated providing for an overflow of the sewage, and taking it away in the case of storms?—I do not think that it would be worth while to provide enormously increased pumping power to deal with an overflow which would only last for a few hours. In some of the heaviest summer storms I should be quite satisfied to let the greater part of it flow into the Thames.

1473. Is it not the case that the Board of Works have provided for this overflow?—Yes, they have weirs in their sewers, so that the water passes over those weirs into the Thames.

1474. Then a considerable quantity of this sewage, which is so valuable, will pass away into the Thames?—A very small portion will pass away in a year. The overflow of two storms in a year, perhaps, will pass into the Thames. If you have an extraordinary storm, that portion which the engines cannot deal with will naturally flow into the Thames; and it is during this period that we bind ourselves to pay the 10*l.* penalty, so that it may be our interest to prevent its overflowing.

1475. Mr. *Hibbert.*] (To Sir *Charles Fox.*) Do you get the sewage in first from the metropolitan outfalls on each side of the river?—Yes, we take it at the five outfalls.

1476. How do you get the sewage into the mains from those outfalls?—There are the pumping stations.

1477. Will the pumping power be found by yourselves and not by the Board of Works?—The present pumping power, which we propose to make use of, is supplied by the Board of Works. Where they have already made the expenditure, we utilise it, but in the other cases we find the pumping power.

1478. Then, in the case of leakage or accident to any of the mains, how do you propose to stop the flow of the sewage?—I am of opinion that the way, instead of using one large main under each road, will be to use two smaller ones; they do that now at Liverpool.

1479. Do you consider that it would be much better to have two mains instead of one?—I think so, but that is a matter of detail.—(Mr. *Smith.*) We have an excess of mains which also provides that in case of any accident we can interchange.

1480. (To Sir *Charles Fox.*) Have you any means of stopping the sewage in case of accident?—Yes, we propose by means of the telegraph to be able to stop it in a few seconds if any accident happens.

1481. Of course in case of damage to private property from leaking of the mains or any breakage, the company would be answerable?—Exactly, as a gas or a water company is.

1482. What sized earthenware pipes would you use?—From 12 inches down to 6 inches.

1483. What plan do you adopt for jointing those pipes?—We joint them with Portland cement.

1484. Would that be sufficient?—Yes, quite sufficient. Inside there are projections which fit into a socket, so that when the socket is put in, and the space filled in with Portland cement, it is pretty nearly as good as the pipe itself, and the pressure of the water cannot blow it out.

1485. (To Mr. *Smith.*) How many tons of sewage per acre do you propose to distribute over those lands?—A little over 800 tons per annum upon the gross area per acre upon some of the lands, and upon others it may be 500 tons; there will not be so much supplied to the cereal crops.

1486. You stated just now that you would like to have such a quantity of sewage thrown upon the lands as would go two or three feet deep; would it not be impossible for cattle to go on it in that case?—I think I can explain that satisfactorily. We never contemplated applying more than an inch per diem. Some portion of the fertilising matter will percolate and go into the soil three feet deep.

1487. Do you contemplate letting your tenants have the sewage at so much per acre?—We contemplate keeping the lands under our own control.

1488. Do you propose to work your lands as grass lands, or arable, or both; and do you propose to send the produce by railway, or to eat it on the land itself?—We propose to consume it on the land. As for talking of sending it to the metropolitan market, even a distance of only 10 miles, it is proved at Croydon that it is better to sell it at a much less price on the land; and if you send it to London, you are increasing the nuisance which you already have in London, of keeping cow-houses.

1489. Then, how do you propose to consume it?—We propose to consume it by having stock on the farms.

1490. Have you anything more to say upon that point?—An Honourable Member asked me a question with regard to the crops. There will be 240,000 acres, and we contemplate that there will be 60,000 acres of wheat, 30,000 acres of barley, 30,000 acres of flax, 30,000 acres of beans, 30,000 acres of clover, and 30,000 acres of grass; and we added 10,000 of grass afterwards, contemplating that there would be other towns whose sewage we should intercept in the same way, and consequently we say that we shall have 40,000 acres for absorbing the ordinary sewage, and we shall have 100,000 acres at our control, to receive larger quantities.

1491. You state, that you expect to get land at the value of 8*s.* per acre annually?—Yes.

1492. What would be the supposed additional value after putting your sewage upon it?—The increased value will be something like from 3*l.* to 5*l.* per acre, or rather more.

1493. Are those osier beds intended to take the surplus sewage, or to take the drainage from the

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the land over which the sewage has flowed?—To take it from the land over which the sewage has flowed, and to pass it through a second filtration before it enters the river.

1494. Then you scarcely expect that the sewage will properly have got rid of its impurities?—There may be some fertilising matter left in it; and if the 5,000 acres of osier beds are not sufficient, we are prepared to free it of all deleterious matters before its entering the Thames.

1495. You state, that you propose to pay 10,000*l.* a-year to the Metropolitan Board of Works; for how many years would you propose to give that amount?—Our tender is for 60 years.

1496. Would it not be more favourable for the ratepayers, that after a certain number of years, they should get some participation in the profits?—We are quite prepared to be satisfied with the 60 years; we run the risk, and we hope to make the profit.

1497. But as a matter affecting the ratepayers, would it not be better that they should have at some future time some participation in the profits, if the scheme is successful?—That 10,000*l.* is 4 per cent. on the quarter of a million.

1498. Mr. *Ferrand.*] (To Sir *Charles Fox.*) Did you not state that you proposed to keep your scheme as much as possible in your own hands?—Yes.

1499. Then, how did you propose to get possession of the lands?—We propose to do that by private arrangement.

1500. Supposing that you found that people would not let you have the lands, what course would you pursue?—Then we must go to Parliament for further powers.

1501. Is the land considered very valuable land?—No; quite the contrary; a great deal of it is of very little value indeed, and, we think, that unless some such means of fertilising that land should come into existence, the land will never be worth anything, and that, therefore, the people will be willing to sell it.

1502. You stated that the overflow on storm days into the Thames may amount to about four days in the year?—I said two days.

1503. If that should occur during two days in the year, would it be to such an extent as to pollute the water, so as to destroy the fish, if the salmon fry were passing up and down the river?—No, it would not.

1504. (To Mr. *Smith.*) You have five outlets into the Thames, have you not?—Those are only our pumping stations; the overflow from those passes down the main sewer into the outfall reservoir; we have no outlet until we get to the main outfall.—(Sir *Charles Fox.*) The Board of Works have made the overflows at spots which are convenient for the present sewers.

1505. (To Mr. *Smith.*) Did not you state a short time ago that on two days in the year there would be an outfall here?—We should have no storm-water except passing to the outfall; we shall have no storm outfall, except what will go down the low level sewers.—(Sir *Charles Fox.*) The Board of Works have provided weirs, over which the storm water will flow in special cases.

1506. Will that be sufficiently strong to destroy the fish in the river?—If you take the whole amount of pollution in the year, and divide it by the number of days, it will be very small indeed; and the Honourable Member must bear in mind that it will be the last portion of the deposit, and not the first portion; it is the first portion that carries away the impurities deposited in the bottom of the sewer.

1507. Did you not state that your first object was to purify the Thames?—I said that our first object was to improve the health of London.

1508. Did you not state afterwards that another portion of your scheme was to take a certain amount of the sewage water of London, and to allow the remainder to flow into the Thames?—That was never our intention; it was only a provision made at the request of the Board of Works.

1509. (To Mr. *Smith.*) Several questions have been asked with regard to the sewage water freezing on the ground; do you expect it to flow through the pipes before it is affected by the frost?—I think that it will never be affected by the frost; I think that the temperature would be of a sufficient height to allow it to percolate into the soil.

1510. What weight of water will flow from the pipes during the time of frost?—It will always be distributed. As I have stated, we have 500 acres of filter beds on our fallow lands artificially prepared every year, and then it will flow to artificially constructed or embanked meadows, to which we should raise the water, and allow it to stand; so that the frost could not affect its fertilising powers, and then we should pass it on to the osier beds, so that there would always be something like from 3,000 to 5,000 acres filtering in case of frost, if it were found necessary.

1511. But you intend the sewage to flow on the surface of the soil, do you not?—On the meadows, and in the osier beds it would flow, but not in the ordinary state.

1512. But what do you do with the sewage in case of frost?—It would percolate through the soil, and pass into the drains perfectly filtered.

1513. Then do you apply it underground?—We apply it to the surface of the filter beds, and it will then pass from there, if the soil will not take it, to the embanked meadows, and afterwards to the osier beds.

1514. But in frosts it will flow on the surface, will it not?—It passes through the first constructed filter beds on the fallow lands; it will then pass through the drains, and over the surface of the embanked water meadows; it will there percolate into the drains, and then pass to the osier beds for filtration, so that we have three filtrations.

1515. Is it your opinion that, however severe the frost is, it will not affect the sewage water?—My impression is, that we shall always be capable of providing lands that will absorb the sewage.

1516. You have stated that there are to be tanks half an acre in size?—The half acre settling tanks are for the pumping stations.

1517. What size would the tanks be that contained the sediment of the sewage?—Half an acre each.

1518. How do you propose to clean them out?—We propose to clean them by a screw and elevator.

1519. Can you do that with ease?—Yes, with ease; we think we can flush them.

1520. What do you do with the sediment?—I think we can pass that by flushing it to the main outfall sewer, where there are elevators; but I even contemplate ultimately carrying that away also.

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1521. Would that sediment, if dried, be valuable as manure?—I think not; the bulk of the fertilising power would be in the sewage in its fluid state.

1522. If you supplied the land from your main pipe, the nearer the land was to London the more valuable the tillage would be, would it not?—I think that it would be very nearly as rich at its extremities as in the immediate neighbourhood of London.

1523. Suppose that you were to supply farmers with this sewage, do you think that they would be more ready to take it from you, and apply it to their lands in open drains or in covered pipes?—They can do as they please about it; but, if I were a neighbour, I should object to the open drains.

1524. Do you think that there would be any smell?—I can only say, from experience, that I have paid dearly for it. I was the occupier of the first water meadows that were constructed by Bakewell in England; those were in Leicestershire. I occupied that land for a considerable period.

1525. Will you inform the Committee what is the objectionable character of that arrangement?—I think that where the sewage is not deodorised, and where there is not a perfect system of drainage, the malaria, or the damp rising, is very injurious to health.

1526. And, therefore, you think that, in order to carry out any large system of sewage, there must be underground drainage?—Yes, I think so.

1527. And deodorisation also?—Yes; I think that Professor Way states that sulphate of ammonia is the best deodorant; he obtained his great analysis with sulphate of ammonia.

1528. In supplying the farmers, do you propose to do it by measure?—I did not contemplate supplying them. I only say that if we do supply them, we will do it, and charge them accordingly.

1529. Could you supply the farmers by measure through the pipes?—Yes, certainly, or by meter.

1530. Do you propose to do it by a gauge?—Yes.

1531. (To Sir *Charles Fox*). Would not the gauge stop the flow of the sediment to a considerable extent?—No; there are plenty of water meters that would let any sewage pass through without the slightest difficulty; in fact, perhaps one of the best is simply a screw beautifully hung, which the fluid turns round in passing through, and regulates the quantity with considerable nicety, by the number of its revolutions, which are registered.

1532. (To Mr. *Smith*). Your plan is not in any way to convey the sewage in open drains?—Certainly not. We might catch it in our water meadows after it had passed through the land once.

1533. But after it had passed through the land once, would all the sediment or odour be extracted from it?—I think I may answer that by stating what has been done at Clipstone Park. The Duke of Portland takes the water from Mansfield, and Lord Manvers asked if he might be allowed to use it after it had passed Clipstone Park, and his Grace said, "I have the ale, and you may take the small beer." But Lord Manver's meadows were quite equal to the Duke of Portland's, if not superior.

1534. But how would you get rid of the produce of the farms?—We should send a certain amount of fat stock to the London market. It would be a great acquisition to the London people, who are badly supplied at the present moment, and we should deliver them an article which would be very much better, because we should send it unheated and unbruised by the transit.

1535. On those farms you would produce an immense quantity of tillage, how would you get rid of that?—There would be no difficulty in sending grain to market; we should convey it to market, and the beans we should consume entirely on the farm.

1536. But how would you dispose of the manure?—The manure, of course, would have to fertilise the land again.

1537. Will you be able to consume upon your own 250,000 acres of land all the sewage of London, as well as all the manure that you will manufacture there yourselves?—I think we shall have to increase our area perhaps 10,000 acres a-year, after we get the land into a perfect state of cultivation, or perhaps when the farmers see what we can do they will be very happy to take the land of us.

1538. Do you suppose that there will be farmers in the neighbourhood who would be able to make use of the enormous amount of manure that you would manufacture?—I think that we should never want to part with it.

1539. But you take 10,000 acres a-year more, do you not?—Yes.

1540. How would you get them?—I think there would be no difficulty in obtaining them.

1541. Mr. *North*.] You take the rent of some of your land at 8*s*. an acre, can you tell the Committee what portion of your 240,000 acres is at as low a rent as that?—I should say much more than half.

1542. And for the other half do you get up to high rates of rent?—I daresay some of it might go up to 30*s*.

1543. Is it your opinion that the application of the sewage is more valuable upon sandy lands than upon other lands?—It percolates much more freely; if you get it upon stiff clays, the clay absorbs it, but it will not pass through.

1544. Upon those rich lands which you have marked on this map, in the neighbourhood of Fulham, and so on, would sewage be of any value at all?—We do not contemplate touching any land within four miles of St. Paul's.

1545. Do you not contemplate dealing with poor land within that area?—The Board of Works object to it.

1546. Would you, or would you not, apply the sewage to that rich sort of land?—I should not contemplate applying it to that rich class of land.

1547. In reference to a question put to you by the Honourable Member for Devonport, do you anticipate any difficulty from having too much manure on your land?—We have not anticipated any difficulty from that.

1548. Then would you send away the produce in the shape of milk and green crops?—Yes.

1549. Mr. *Adderley*.] In your first deposit do you contemplate any process of filtration?—In the first deposit we did.

1550. I understand you to state, that your first discharge from the deposit tanks passed through a filtration by its passage over the first lands, and through a second filtration by its passage over the osier beds; was not the second filtration really

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really a third filtration?—It was only with regard to cases of frost that I was asked the question.

1551. Then, in your first tanks is there a filtration or not?—There is no filtration, it is merely a deposit.

1552. (To Sir *Charles Fox*.) Is it a simple gravitation?—It is, in fact, to permit that which is in mechanical suspension to fall to the bottom, and that which is in chemical solution it does not touch at all.

1553. Have you made any calculation as to the value of that deposit?—That deposit is of very little value; I can only say that I should be very much obliged to anybody to remove it.

1554. (To Mr. *Smith*.) How will that deposit be removed?—It is removed by barges, if we cannot pass it through the mains; but I rather anticipate ultimately passing it through the mains.

1555. At what period of your whole process would the deodorisation take place?—The deodorising process would take place as it passed over the settling-tanks into the wells, or into the second reservoir, from which we pump.

1556. Then, in fact, it would be part of the process of deposit?—No; after it had given its deposit in our settling-tanks, when passing over the weirs into the wells, it would there be deodorised.

1557. Then the deodorisation would not take place except upon the overflow from the deposit?—When we were removing the residue or the deposit, if it was necessary, we should deodorise that; but that which we contemplate moving before 8 A. M. would hardly require deodorisation, because there would be no time for decomposition to take place.

1558. Then the deodorisation process would take effect on that liquid in which you consider the whole virtue of the manure to be contained?—Decidedly.

1559. From your experience at Leicester what effect upon the manurial value of the liquid would the deodorising process have?—It would improve it materially. When the Honourable Member refers to Leicester, I will explain that the experiment at Leicester failed on chemical principles.

1560. Will you state the difference between the deodorising material at Leicester and that which you propose to use?—We propose a deodorant, to hold the ammoniacal salts in a neutral state; the system adopted at Leicester was by adding quicklime to ammonia, and by that means freeing the ammonia, and allowing it to become a volatile spirit.

1561. Then do you think that you can deodorise the sewage and increase the value of it at the same moment?—No doubt.

1562. In your opinion, is the ordinary fall of rainwater, excepting storms, not more than is sufficient to carry off the sewage?—I think it is not sufficient in dry weather; I think that flushing powers ought to be obtained, and I have no hesitation in saying that that can be done. I will furnish the Committee with details to show how we can provide for that, if necessary.

1563. After the water has passed through your first fields and got to the osier-beds, do you contemplate that it will still have fertilising value?—I said that, if we found that it had, we should still have sufficient filtration.

1564. Did you not state that the deodorisation rendered the sewage more valuable?—I said that it was quite as valuable; and that is the reason why we would provide extra filtering, to absorb any extra fertilising ground that we might have left.

1565. You mentioned a value of 1½ *d.* per ton, did you not?—I said that that was Professor Liebig's estimate upon Professor Way's analysis, and Professor Way's analysis was obtained as a sulphate of ammonia; that was why I said that sulphate of ammonia was the best deodorant that we could get.

1566. Is that the value of a ton of the liquid?—One penny per ton is more than can be obtained for it. The farmers will look round their premises, and when they see the thing developed they will see that they have means of obtaining the fertilising matter at less than 1 *d.* per ton.

1567. Have you calculated that it is better to deposit first, and afterwards to deal with, the liquid, than to get the whole of the sewage discharged together through the pipes?—I think that the heavier silicious and the iron portions of the sewage, or at any rate the iron, are certainly injurious, and we should be very happy to get rid of that if we could.

1568. Do you still think that it is better to make the deposit, and to deal with the liquid?—I think that it is not practicable to deal with the fertilising matter in a solid state.

1569. Do I rightly understand you to state that in your Act you take no power to deal with the lands of those people who do not fall into your plan?—We take powers for laying down the pipes.

1570. But do you take powers for purchasing land?—We take no absolute powers; in the first instance we take powers only for the passage through the land.

1571. Will you state, generally, what the nature of those powers are?—They are the same powers as a water company, or as a railway company have under the Lands Clauses Act.

1572. Dr. *Brady*.] You state, do you not, that you think that 800 tons per acre per annum would be sufficient?—I think it is rather more than sufficient; but grasslands will absorb more.

1573. It has been stated to this Committee that it will take 8,000 or 9,000 tons an acre to be sufficient; what is your opinion upon that point?—I think that that is a great deal more than is necessary, or more than, if I was in the neighbourhood and had any control over it, I should allow to be used, if I could avoid it.

1574. It has been stated that 20 *l.* or 30 *l.* worth of produce could be got per acre; are you aware that 40 *l.* or 50 *l.* an acre is given for the produce of the land at Craigentinny?—I am.

1575. If sewage can produce, in Scotland, such large crops, why, with a judicious administration of the sewage, could not similar crops be produced here?—In the first instance, the Craigentinny meadows are upon the imperial acre, and we are computing the crops here upon the statute acre; that is the great difference between the value of the produce in this case, and the value of the produce of the Craigentinny meadows.

1576. *Chairman*] That is as 5 to 4, is it not?—It is as 5½ to 7.

1577. Dr. *Brady*.] That is not a very great difference, is it?—In a money value it is.

1578. What is the largest amount of value that you expect per acre for your land?—We should

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should be very well satisfied with 10*l.* or 12*l.* per acre.

1579. Could you get 12*l.* an acre?—I said 10*l.*

1580. If you would apply 800 tons per acre upon that land at 1*d.* a ton, you would have close upon 8*l.* profit per acre; 800 tons at 1*d.* a ton comes to 3*l.* 6*s.* 8*d.*, does it not?—Yes.

1581. (To Sir *Charles Fox.*) If you get 10*l.* do you not get nearly 7*l.* profit?—You must take the labour into consideration too.

1582. But is not the labour calculated in your original scheme?—The labour is included in our annual expenditure.

1583. (To Mr. *Smith.*) Then you would have upwards of 7*l.* an acre of profit, would you not?—I think not.

1584. If you get 6*l.* 10*s.* profit upon the acre, do not you think that you could afford to give more than 1*d.* a ton for the sewage?—I think that there is the labour to calculate after that.

1585. If you get 6*l.* 10*s.* an acre profit, do not you think that you could afford to give more than 1*d.* a ton for the sewage?—I think that 1*d.* a ton is quite the outside.

1586. But could you not afford to give more than 1*d.* a ton for the sewage if you got a profit of 6*l.* 10*s.* per acre?—It is a matter of calculation as to what can be got rid of, and the expense of plant, and the interest that would come against it, and the labour.

1587. You have got 250,000 acres of land; you apply 800 tons of sewage to each acre of this land, and you will get, as a result, 10*l.* an acre, giving you a profit of 6*l.* 10*s.*: do not you think, if that be so, that you could afford to give more than 1*d.* a ton for the sewage?—We must have every other item of expenditure taken off besides that.

1588. Did you not state that the expenditure will be 2*l.* an acre for the tillage?—I said for the labour.

1589. There are no other expenses, are there?—There are very considerable expenses.

1590. Will you name them?—There are rent, taxes, seed-corn, superintendence, and every other expenditure. I will make out the details, and send them to the Committee.

1591. Mr. *Ferrand.*] Do you calculate the rent at 8*s.* an acre?—That is the rent at its present value.

1592. You expect to take it at 8*s.* an acre, do you not?—Yes; but then there is the expenditure for the plant, and the interest to be paid; that will bring it up to more than 2*l.* an acre.

1593. Dr. *Brady.*] Do you believe that at Clipstone Park, after the sewage had passed away from the first estate and went on to the other, it produced great improvement?—I only say that that was Lord Manvers' opinion.

1594. What do you mean by Professor Way's analysis?—Professor Way was employed to make an analysis of the London sewage.

1595. By whom was he employed?—I cannot say whether it was by the Agricultural Society or by the Board of Works.

1596. Have you read Professor Way's works?—I have read a part of them.

1597. Are you aware that Professor Way has stated that the earth was the best deodoriser?—I am aware that he has stated that the earth is the best natural deodoriser.

1598. Are you not aware that he states that five minutes after the application of the strongest sewage there is no smell?—If he told me so I should not believe him.

1599. If you believe one thing which he says, why do you not believe another?—Because my own practical experience bears me out in believing the contrary; I do not profess to be an analytical chemist.

1600. Have you had any practical experience of the application of the sewage?—I have had some experience of town sewage. I think I have had the application of sewage almost equal to what the Duke of Portland had at Clipstone Park.

1601. You stated, did you not, that it would be necessary to increase your farm each year by 10,000 acres?—I said that it might be necessary.

1602. If you do not do so, how would you get rid of the surplus sewage?—We shall have applications from farmers. After they see the beneficial effect of the sewage, then they will take the sewage from us.

1603-4. Then your proposition of 250,000 acres is not sufficient?—The 250,000 acres in 10 or 15 or 20 years' time might not be sufficient.—(Sir *Charles Fox.*) Allow me to say that that is contemplating a very delightful result. I only hope we may want 10,000 additional acres every year.

1605. Mr. *Ferrand.*] You were asked what the outlay was likely to be for an acre of land; your statement is that it would be 3*l.* 6*s.* 8*d.* for the sewage, 2*l.* for the labour, 8*s.* for the rent, and 2*l.* for plant and other expenses: that amounts to 7*l.* 12*s.* 8*d.* before you receive any profit on your scheme; is that so?—That would be something like it.

Mr. G. SHEPHERD, called in; and Examined.

Mr. *George Shepherd.*

1606. *Chairman.*] You propose to deal with the sewage in a fluid state, do you not?—Yes.

1607. In your tender you did not furnish the Metropolitan Board with any details of your plan or of the expenses of your works?—I did not.

1608. Your plan had already been before the public for some years in this prospectus of the "London and Provincial Sewage Manure, Drainage, and Land Improvement Company"?—Yes; I think I sent your Lordship a pamphlet on the subject. It has been before the public since 1857, and previously to that.

1609. This was brought out in 1859, was it not?—Yes, it was.

1610. Are you the Engineer to this London and Provincial Sewage Company?—I am.

1611. In that prospectus you state, that "it has been clearly demonstrated in the work published by George Shepherd, Esq. C. E., the engineer to the company, entitled 'London Sewage, and its Application to Agriculture,' that the sewage can be delivered to a distance of 100 miles round London, and on every farm included in that area, at one-fourth the cost of guano to the farmer, and at a good rate of interest on the capital employed in constructing the necessary works": is that a true statement?—Yes.

1612. At page 53 of your pamphlet of 1857, you say,

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say, "It will be seen, from the following analyses of Peruvian and African guanos, that the town's sewerage contains every element of the best guanos, but in a less concentrated form, yet in a far better state for assimilation with the land; and if it will pay to bring guano so many thousands of miles, it will equally pay to distribute the sewerage of London within a circle of 100 miles round London": is that the passage that you refer to in this prospectus?—Yes.

1613. Do you consider that you have "demonstrated" that here?—I think I have, and I shall be able to do so in the course of my evidence.

1614. Whether it will pay to deliver it to farms 100 miles round London must depend very much, must it not, upon the cost of the works of distribution?—My mode of distributing it would be equal in expense on those 100 miles to those close to the town.

1615. But whether it would pay to deliver it 100 miles round London would depend upon what you will pay the Metropolitan Board of Works for the sewage, and upon what the works will cost you; is not that so?—I do not propose to pay the Board of Works anything. I propose that all surplus that the Company gets above 7½ per cent. is to be equally divided between the Board and the Company.

1616. Then, whether it will pay to deliver it on 100 miles round London depends upon the cost of your works of distribution?—Decidedly.

1617. You propose, do you not, to supply the farmers with the sewage, *ad libitum*, at the rate of 30 *s.* per acre per annum?—When I took up this question nothing was known about it, and I was induced to commence a factory on the Surrey side of the Thames. It was reported to Mr. Robert Stephenson, the late eminent engineer, that it could be done, and I took it up; but we found, as we proceeded, that the solid matter which we took from the sewage was utterly valueless, and I then discovered (and I was the first to solve the problem) that the fertilising matter was all in the liquid itself.

1618. Do you propose that the farmers should pay you 30 *s.* an acre and be allowed to take the sewage *ad libitum*, or what price do you think would be a fair one?—The sewage is worth ¾ *d.* per ton in very wet weather, 1 *d.* per ton in wet weather, and in very dry weather it is worth 2 *d.*; so that the average price is 1¼ *d.*

1619. In the letter that you wrote on the 15th of February last, you state that Professor Way and the Earl of Essex put the value of the sewage at 2 *d.* a ton; is that so?—That is at the present rate of agricultural produce; but if you come to apply the sewage generally, and each farmer has got early grasses at the same time, you could not expect it to keep up that rate.

1620. What do you expect that each farmer will pay you for the sewage?—One penny farthing. You would get, practically, eight tons of grass at 12 *s.* a ton; that would amount to 4 *l.* 16 *s.* for each cutting, and you can cut four times a year with manure. The cost of the sewage to the farmer would be 1 *l.* 11 *s.* 3 *d.*, and the cost of irrigation 5 *s.*; that would leave 2 *l.* 19 *s.* 9 *d.* for the farmer for cutting, and after that he would sow aftercrops for the spring.

1621. With regard to your works of distribution; you propose to lift the sewage by steam-power into a large reservoir at each side of the Thames; is not that your proposal?—Yes, that was proposed by me in 1857; I proposed to pump it on to Shooter's-hill on the one side, and on to Hampstead-hill on the other side, and then to let it flow into the district reservoirs.

1622. And you proposed to irrigate 15,000 acres from each of your district reservoirs, did you not?—I think it is about four square miles; it is continually kept in motion. I have shown the four square miles that that would irrigate.

1623. In your prospectus do you not propose to irrigate 15,000 acres from each of those district reservoirs?—1,280 acres; that is, two square miles.

1624. Will all those district reservoirs be at different levels, or at the same levels?—I should drop upon them where it would be convenient.

1625. Would they be built of brick or stone?—Brick.

1626. Would they be covered?—No, I should not propose to cover them.

1627. If they are not covered, and if they are not at the same level, how do you provide for the sewage not all running into the lowest one, and there running out?—When one is full it goes on to the others.

1628. Are they taken in regular order?—Yes, they are taken in regular order; when the lowest is full it will go to the others. The head of water will be great on the high-level reservoir; it will not be less than 300 feet; the others, perhaps, will not exceed 80 feet, or so on.

1629. But why will it not all overflow at the lowest?—It can only go when it is full; I have a ball-tap, which shuts it off when it is full.

1630. By your prospectus you allow a uniform amount of 3,000 *l.* for building each reservoir, and for the purchase of the land, "with stand-pipes and apparatus complete"; is that so?—When this plan was designed the main-drains had not been commenced, and I proposed for this engine-station to intersect the Fleet Ditch Sewer. My high-level reservoir is on Hampstead-hill, and from there it flows along the mains; but since that I have proposed to put them nearer together, for the sake of keeping a large stock of sewage for the farmers to irrigate with at all times, because if I had only one reservoir in London, and the farmer wanted the sewage, he would never get it. Mr. Ellis's plan, I may say, is taken from mine entirely.

1631. You have got a stand pipe at each reservoir; does the sewage pass over the stand-pipe?—I dispense with the stand-pipe; in filling, it flows over the top, and there are two valves which open inwardly.

1632. Then it is not really a stand-pipe?—It is what we commonly call a stand-pipe.

1633. It is only at the height of the level of the reservoir itself?—It is a little above, just to keep the whole affair in play.

1634. Does the sewage gravitate to those reservoirs?—Yes; it flows in from the mains, while the farmer draws from the main also, and the water is supplied back again to the reservoir.

1635. Does it come along to those district reservoirs merely by gravitation from the summit reservoir?—Yes.

1636. Does it then flow out again to the farmers?—Yes.

1637. Then are not the reservoirs merely like aneurisms or enlargements of the pipe?—They are bricked: they are about 15 feet deep, and they hold 3,000,000 gallons of sewage.

1638. Do you prevent its running out of the reservoirs?—No; it runs out as it is wanted.

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The main is laid down alongside the road, and the reservoir is on the hill.

1639. Does it flow in by pressure from the summit reservoir?—Yes.

1640. Does it flow out of itself as soon as the reservoir is full?—It is shut off by a ball-tap to the sewer; that supplies the reservoir, and then the farmer takes it and draws it off.

1641. Do you allow five miles of 24-inch sewage-mains for each district reservoir?—Yes. I have altered it since then; I found that I could not do it at that rate.

1642. That would be five miles of main to about 15,000 acres of ground, would it not?—Yes; something about that.

1643. That is about 25 square miles, is it not?—Yes.

1644. That is one mile of main to five miles of country?—Yes; but I should rather confine myself to the plan which I propose for Birmingham.

1645. How many miles of main would you allow?—One mile of 18-inch main for each two square miles of land.

1646. And you allow for "small mains, and laying the same to estates and farms, 10 *s.* an acre;" would that be the cost?—That would be about the cost.

1647. Do you put those items at 7,500 *l.* for each district reservoir?—Yes, that is the estimate that was then made; but that estimate was made six years ago, so that it is hardly correct.

1648. Then how much would you charge for laying it to estates per acre?—Assuming that each two square miles of land, or 1,280 acres, will require one mile of 18-inch main and 3,000 yards of other mains, from 6 to 12 inches in diameter for bye roads, and so on; the cost per mile would be as follows, 1,760 yards of 18-inch main, at about 1 *l.* 14 *s.* per yard, would be 2,992 *l.*

1649. You say that the 24-inch sewage mains weigh "528 tons of iron per mile"; is that correct?—Yes, that would be correct; all is correct that is stated in the prospectus.

1650. You allow 1 *l.* per nine feet for laying those mains, do you not?—Yes.

1651. You say, "To five miles of 24-inch sewage mains, at 528 tons per mile"; would that be for each district reservoir?—They would run from the main reservoir in London right through, and take the district reservoirs in their ordinary course.

1652. That, "at 6 *l.* per ton," comes to 15,840 *l.* for each reservoir?—Yes.

1653. Then you allow 1 *l.* per nine feet for laying it?—Yes.

1654. This you state would come to 1,000 *l.* for five miles, or 200 *l.* a mile?—Yes.

1655. But at 1 *l.* per nine feet, would it not cost more than 1,000 *l.* for five miles; there would be 8,800 yards in five miles, and this, at 1 *l.* per nine feet, would be 2,933 *l.* 6 *s.* 8 *d.*, would it not?—Yes, if that is correct, that would be so.

1656. That would be 586 *l.* 14 *s.* per mile, would it not?—Yes.

1657. Then it would not be 200 *l.* per mile, but 586 *l.* 14 *s.*?—I think this is an error in the printing.

1658. You allow "20 tons of lead for socket joints for pipes at 21 *l.* per ton"; is not that so?—Yes; I would simply state that those estimates were sent to me by a contractor who offered to do the work.

1659. This would be equal to 420 *l.* for five miles, or 84 *l.* per mile, would it not?—Yes.

1660. Those calculations are given in your "estimated cost of works for applying the London sewage to an area of 500,000 acres of land in the first instance, or equal to a distance of 40 miles round London"; then you stated, in your prospectus, and in your work of 1857, "that the sewage can be delivered to a distance of 100 miles round London, and on every farm included in that area, at one-fourth the cost of guano, and pay a good interest on the capital"?—Yes.

1661. The object of the Committee is to ascertain the cheapest and most effectual mode of distributing the sewage; what are your views as to the cost per acre?—The cost per acre would be the cost of main reservoirs and other things, which at the present price of iron would be about 4 *l.* 7 *s* per acre.

1662. In your pamphlet you stated that it would be 5 *l.* 3 *s.*; is iron cheaper now?—Yes.

1663. In your letter to the Metropolitan Board of Works, of the 15th of February last, did you not give 2 *l.* 10 *s.* as the cost?—I could have got iron very much cheaper then. For large areas I could do it very cheaply.

1664. Then what would be the cost for distributing the sewage over 100 miles around London?—The cost of distributing the sewage over 1,565 square miles, at 3,805 *l.* per square mile, would amount to about 5,000,000 of money.

1665. You allow in this prospectus 15,000 acres for each district reservoir; and for each reservoir, and the purchase of land for the same, did you not state that the cost would be 3,000 *l.*?—I think that is about it altogether.

1666. If we carried out the calculations over the whole area we should be able to find out for ourselves the cost of the works, should we not?—Yes.

1667. How do you calculate the number of acres in a circle of a given radius or diameter, say a radius of 50 miles round London?—Get the area and multiply it by 640 acres to one square mile.

1668. How do you find the number of square miles in that circle?—By the usual rule; squaring the diameter and multiplying by 0·7854.

1669. What would that be in the case of a diameter of 100 miles, or a radius of 50 miles?—7854 square miles.

1670. How many acres would that be?—5,026,560 acres.

1671. Now, if we take a radius of 100 miles round London, we shall find 31,416 square miles, or 20,106,240 acres?—That would be so.

1672. Now, returning to the calculations of the cost of distribution, taking one mile of 24 inch main to five square miles, that would be 6283·2 miles of main, would it not?—I suppose it would be about that.

1673. Calculating 528 tons of iron to the mile, that would weigh 3,317,529·6 tons, would it not?—Yes.

1674. Would that, at 6 *l.* per ton, cost 19,905,177 *l.* 12 *s.*?—Yes.

1675. And the cost of laying the mains, at 1 *l.* per 9 feet, over 6,283·2 miles, would come to 3,686,144 *l.*, would it not?—Yes.

1676. The lead for jointing those mains, at 20 tons for 5 miles (that is, 4 tons per mile), costing 21 *l.* per ton, that is 84 *l.* per mile, would amount to 527,788 *l.* 16 *s.*, for the 6,283·2 miles, would it not?—Yes.

1677. Ten shillings an acre for the small mains and

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and laying the same to estates over an area of 20,106,240 acres would amount to 10,053,120 *l.*, would it not?—Yes.

1678. And one district reservoir to each 15,000 acres, at 3,000 *l.* for each reservoir on 20,106,246 acres would be 1,340 reservoirs, and that would cost 4,020,000 *l.*, would it not?—Yes.

1679. Supposing that is correct, this would be your account for the works:

	£.	*s.*	*d.*
6283·2 miles of mains, at 6 *l.* per ton - -	19,905,177	12	–
Cost of laying - -	3,686,144	–	–
Cost of lead for jointing	527,788	16	–
Cost of small mains -	10,053,120	–	–
Cost of 1,340 reservoirs	4,020,000	–	–
Total - £.	38,192,230	8	–?

—I never made any calculations for 100 miles round London.

1680. Is not this correct?—It is the cost if it was carried to 100 miles round London.

1681. You state, do you not, that it can be carried to a district of 100 miles round London?—Decidedly; if there was sewage enough I would carry it much beyond that.

1682. But what is the cost of carrying it to such a distance?—Those are figures that frighten me.

1683. How much should you add to that for the engine power?—I will send that in to-morrow.

1684. The rent you propose is 30 *s.* an acre, is it not?—That we proposed then.

1685. That, over 20,106,240 acres, would give you a revenue of 30,159,360 *l.* per annum, would it not?—Over the 100 miles it would; I can carry it over 100 miles, provided there is enough sewage to irrigate that distance; but I have not at all attempted to put it in that form; I have simply put it for each 15,000 in this area.

1686. What would be the cost of distribution, and what would be your revenue?—If we go into such figures as those we shall frighten capitalists from taking it up.

1687. If you get 30 *s.* per acre, the price which I have named would be correct, would it not?—Yes, in that case it would.

1688. You state, in this prospectus, that the net amount of the sewage of London is 200,000,000 tons annually; is that correct?—No; it is much more than that; at that time nobody had ascertained the amount.

1689. Is it more than that?—Infinitely more. We know nothing about it, but it is put at about 300,000,000 tons, but it is twice that.

1690. Taking it at the smaller figure at 2 *d.* a ton, how much would that amount to?—£ 1,666,666 13 *s.* 4 *d.*

1691. You state that you can deliver it at a quarter the price of guano over that area; is that so?—Yes, I think you can, comparing the value of the sewage with the value of guano.

1692. That would be a halfpenny a-ton, would it not?—Yes.

1693. Messrs. Hofmann and Whitt state in their analysis, and you corroberate it in your letter of 15th February 1864, that taking guano as the standard at 11 *l.* a ton, the sewage would be worth 2 *d.* a ton?—No, I take Professor Way's analysis of the sewage as to what it would be worth, but I have taken the value of the sewage of the human excreta, and I have taken three persons residing in each town to manure one acre of land.

1694. Messrs. Hofmann and Whitt, and Professor Way state, and you have corroborated their statement, that if you take guano at 11 *l.* per ton, then the amount of fertilising matter in one ton of sewage will be equal to 2 *d.*, is that so?—That is at the present rate of agricultural produce.

1695. But do you not state that you could deliver the sewage at a quarter the price of guano?—I should say much cheaper than that.

1696. Then you could deliver it ½ *d.* per ton?—The cost of pumping the sewage, including wages, oil, tallow, and hemp per ton, would be ·148 *d.*, and the general charges upon engines, pumps, cleaning, and repairs per ton, would be ·053 *d.* I could pump it, including everything, and deliver it complete at ½ *d.* per ton, and my calculations are backed by one of the most eminent engineers in Cornwall, Mr. Hocking, of the firm of Hocking and Loam.

1697. Then, you can deliver it at ½ *d.* a ton?—Yes, including everything except interest on capital.

1698. Then the gross revenue for all the sewage of London would amount to a little more than 416,000 *l.*, would it not?—The gross revenue which I should get, after laying down the works, constructing the engines and everything connected with it, would be about 14 per cent. per annum, not more.

1699. If you received ½ *d.* per ton for the sewage of London, would you not, in fact, be receiving 416,000 *l.* a-year?—I have not gone into those big figures, and I had rather confine myself to smaller areas, and give the cost of laying the mains and engine-power required for a certain area, the cost of pumping, and what that would give us.

1700. What terms do you offer to the Metropolitan Board of Works?—I offered that, when our revenue exceeded 7½ per cent., we would divide all surplus with them.

1701. In your tender (No. 74, p. 5), you stated you were engineer to the Croydon Sewage Irrigation Company, did you not?—I was; but it came out in that very bad harvest year.

1702. Baron Liebig's name is down as consulting chemist; was he appointed by the company?—Yes; and your Lordship will see his own letter accepting the appointment.

1703. Were the bankers the City Bank, and the secretary, Mr. Ensell?—Mr. Ensell was appointed secretary just at the first; afterwards Mr. Bowing.

1704. You have written on this prospectus these words: "This Company was formed and registered, but they brought it out in 1860, during the wet bad year, and it failed for want of support"; was that the only cause of its failing?—That was the only cause of its failing.

1705. The prospectus states that a concession of the sewage had been granted to you for 50 years, and the right of using the parish roads for mains and works; was that the case?—Yes.

1706. Did you form a direction?—Yes; the names are there.

1707. Were there any shares taken?—We could not float it at all; the harvest was spoiled by the wet season, and money ran up to 10 per cent.

1708. In this letter to Mr. Thwaites, dated the 15th of February 1864, you sign yourself "Engineer to the London, Midland Counties, and General Sewage Irrigation Company"; what does that mean?—I should rather not refer to that, for certain reasons; there is a company coming out in a few days.

1709. Are you the engineer to that company?—Yes, I am.

1710. Sir *Joseph Paxton.*] Is that an imaginary company?—No; some of the most eminent merchants in the City are connected with it.

1711. *Chairman.*] How long has that company existed?—It is just formed; the Earl of Shrewsbury is at the head of it. I have his Lordship's letter, and I saw him only a very few days ago; I had proposed to mention his name.

1712. Do you state positively that he has consented to join this company?—Yes. He said, "Provided you can get a few gentlemen of my own standing to be on the Board, I will join it."

1713. Is the company formed?—It is formed.

1714. Sir *Joseph Paxton.*] You cannot call a company formed until it is registered, and so on?—I think you will see it in a very few days.

1715. It is a proposed company?—It is a proposed company.

1716. *Chairman.*] In your tender, which is contained in this book, which Mr. Thwaites has put in, you state that an experiment will be tried with the sewage of one of the large towns in the midland counties; is that Coventry?—Yes.

1717. Have you begun those works?—No; I have got the concession, and am arranging for the land, and we propose to carry it out at Coventry first.

1718. When was the concession granted to you?—It has been granted for some time.

1719. I have written to the mayor of Coventry, and he has replied, enclosing a note from the town clerk of Coventry, in which he states that that is not the case; can you explain that?—I have got the promise when once I have formed the company.

1720. He states that you have no concession; is that so?—I have got a concession, positively; I am almost in daily correspondence with him on the subject.

1721. Sir *Joseph Paxton.*] There seems to be a great mistake about that, is there not?—I have letters promising it to me, and there could be no difficulty as soon as the company is formed; I have even got the resolutions of the Board promising it to me.

1722. What are you going to do?—To put the sewage over the lands. Not only that, but when Lord Shrewsbury went down to the Shakespeare Festival, he went to ask Lord Leigh to join us also.

1723. Are you not aware that they have a system of sewage which has been carried out there for the last seven years?—They have simply drained the town.

1724. Have they not a system of deodorising, and also applying the manure?—They have simply drained the town, and it runs into the stream, and I propose to take it from there.

1725. Dr. *Brady.*] This is a letter to the noble Chairman from the town clerk of Coventry: "My Lord, the mayor of Coventry has requested me to reply to your Lordship's inquiry as to whether all the sewage of Coventry has been leased to Mr. George Shepherd. I beg leave to inform your Lordship that such is not the case. There was a negotiation with Mr. Shepherd, but as he failed to comply with the requirements of the corporation he was informed by me, on the 4th of August last, that the proposed arrangement must be looked upon as at an end, and that, if anything further were done, we must begin *de novo.* Although Mr. Shepherd has written to me one or two letters since, that is how the matter really stands at this moment. I have the honour to be, my Lord, your most obedient servant, *Thomas Prowett,* Town Clerk;" have you any remarks to make on that?—My letter reads that there will be no difficulty as soon as we have formed a company.

Lunæ, 30° *die Maii* 1864.

MEMBERS PRESENT:

Mr. Adderley.
Mr. Sclater-Booth.
Mr. Bright.
Mr. Caird.
Mr. Cowper.
Mr. Ferrand.
Mr. Hibbert.

Mr. Leader.
Lord Robert Montagu.
Mr. North.
Sir Joseph Paxton.
Sir Frederic Smith.
Mr. Tite.
Sir William Russell.

LORD ROBERT MONTAGU, IN THE CHAIR.

Mr. THOMAS ELLIS and Mr. JOHN BOWING, called in; and Examined.

Mr. *T. Ellis* and Mr. *J. Bowing*.

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1726. *Chairman.*] (To Mr. *Ellis.*) With regard to a letter of Mr. Shepherd's, dated 3d December 1861, in the papers which have been referred to this Committee by the House, is it true that you are "an Irish solicitor," that you have been "struck off the Rolls," and that you have not the slightest knowledge of the subject about which you have troubled the Board?—A part of the charge is true; I am an Irish solicitor, but I have never been struck off the Rolls; I have ceased to practise for many years, because I did not like the profession; but if your lordship will allow me, I will write to Ireland for further proof and place it on record.

1727. You have a plan, have you not, for the distribution of the whole of the sewage of the metropolis over a very large area?—Yes, the works were to be laid down over an area of 1,680 square miles, to enable me to take the sewage over 500,000 acres.

1728. Do you propose to retail it to farmers, or to employ it on land in your own hands?—I propose to retail it entirely to farmers.

1729. There is a preliminary point which must be first established, because the whole of the value of your plan rests upon the correctness of your estimate of the value of the sewage. Will you state the capital which you require for your works?—The exact capital which I should require, it would be impossible for me to state until I had made an accurate survey of the area taken, and of the levels, for a very heavy item would be the engine-power, and until I take the levels, I cannot tell what the engine-power will be. In the estimates which I forwarded to the Board of Works, I assumed that it would be necessary to pump to a very high point.

1730. Could you give the approximate amount of your capital?—I have reason to think that the estimate for the works will not exceed, or will not amount to 4,000,000 *l.*

1731. Do you think that you could hope to raise so large a capital as you would require, unless you could prove that a utilisation of the sewage, such as you propose, would be a commercial success?—Certainly not.

1732. Are you an agriculturist?—I was specially educated with a view to taking the management of land, my father being one of the largest land agents in Ireland, and I assisted him for many years.

1733. Then do you understand agriculture?—I believe so.

1734. Do you base your calculations on your own experience?—No; my own experience has been a guide to myself; but I have never brought my own experience as any proof of my assertions. I have based my calculations entirely upon other things; upon the value of the sewage, and upon the results obtained by parties who have used sewage which is as diluted, if not more diluted than that of London.

1735. How then do you prove the manurial value of the sewage of towns?—The manurial value of the sewage of each town would of course be determined by an analysis of that sewage, but I base my calculations as to the value of the London sewage upon the analysis made by Hofmann and Witt, which will be found in the Report of the Metropolitan Drainage Committee, ordered by the House of Commons to be printed on the 3d of August 1857.

1736. Messrs. Hofmann and Witt, say that in 1,250 tons of sewage there is as much fertilising matter, supposing it to be all dried, as there would be in one ton of guano; is that so?—That is the result.

1737. Taking that at 11 *l.* a ton, would that give the value of 2 *d.* a ton for the sewage if extracted and dried?—Yes.

1738. Has this value been questioned?—It has been questioned of late by certain gentlemen connected with the artificial manure trade, and I have been denounced in the public papers for hoodwinking and deceiving the public in stating that the average sewage of the metropolis is worth 2 *d.* a ton. Perhaps your Lordship will permit me to point your attention briefly to this report of Messrs. Hofmann & Witt, which I think establishes the view which I take as regards the value of the London sewage. At page 1 of the Appendix in the Report of the Metropolitan Drainage Committee, I find a letter from Herbert C. Saunders, the secretary to the referees, containing instructions to Messrs. Hofmann & Witt, in which will be found the following: "Without going into all the minute details of analysis of the various objects to which they will have to call your attention, I may state generally that they will require a statement of your views: 1st. As to the influence of sewage upon the river, as represented by specimens taken under the direction of the referees from various point at high and low water. 2d. As to the actual agricultural value of the London sewage, determined from specimens collected for that purpose." Now I am of opinion that the actual agricultural value of the London sewage could not be determined from the analysis of a fancy specimen, but from average specimens of the sewage. At page 8 of the Appendix, under the heading "Mean Composition and Agricultural Value of London Sewage," the mode of collecting the samples is shown, where they state, "Since it was found that the composition of the sewage varied considerably at different hours of the day, containing a much larger amount of fœcal matter at from 8 to 12 a.m. than at any other portion of the 24 hours, and being extremely dilute between 12 at night and 5 or 6 o'clock a.m. it was found convenient, in order to arrive at a knowledge of the mean composition, to collect samples of equal volume at every hour during the 24, to mix these together and then analyse this mixture." At page 9 will be found the analysis of two specimens of that mean sewage. At page 10 the Messrs. Hofmann & Witt, referring to that analysis, state as follows: "The results of these two experiments agree as well as could be expected in a case of this kind: in fact, the quantities of dissolved matter in the two experiments almost coincide. Nevertheless, we are fully aware how desirable it would have been to have our calculations based upon a broader experimental foundation. Considering, however, that the object of this inquiry was nothing more than to obtain a general idea of the value of sewage, we believe that we were not very far from the truth in adopting the mean of the two experiments given above as a starting point for calculation. We shall have an opportunity in the latter part of this chapter of uniting in a table a number of analysis of sewage water which, in the prosecution of this inquiry, were made for different purposes. It will be found that a correct interpretation of these experiments leads to nearly the same result. We shall also quote a number of observations made by other inquirers, which, with a few local exceptions, are likewise in favour of the number deduced from our experiments."

1739. Could you not give that in fewer words?—I wish if possible to give the exact words, this affects my credit, because I have been held up to the public as something very like a swindler. Then follow the calculations, and at page 12 they give the result thus:—"From these data we readily ascertain the money value of a certain weight or volume of the sewage itself; 100 tons of sewage contain:—Suspended matter, 82·72 lbs. at 3 *l.* 0 *s.* 8½ *d.* per ton, value 2 *s.* 2½ *d.* Dissolved matter, 245·95 lbs. at 3 *l.* 0 *s.* 8½ *d.*, value, 15 *s.* 4½ *d.* Total, 328·67 lbs., at 6 *l.* 0 *s.* 3 *d.*, value of 100 tons, 17 *s.* 7 *d.*" And then at page 13, under the head of "Money value of total sewage of London," Messrs. Hofmann and Witt state as follows:—"We learn from the referees that the average quantity flowing into the river per day may be roughly stated at 95,000,000 of gallons. About 220 gallons weigh a ton, or 95,000,000 about 431,850 tons. These at 17 *s.* 7 *d.* for 100 tons, give as the daily value of the London sewage 3,796 *l.*; and annual value 1,385,540 *l.* But from this brief epitome of the Report of Messrs. Hofmann and Witt it will be seen that they received instructions to determine the actual agricultural value of the London sewage, and not of a fancy specimen; and that after having ascertained the money value of the manure in a ton of the average sewage, they then upon that basis proceeded to calculate the money value of the total sewage for the year, and the only question really undecided is, did they take too large or too small a quantity as the total annual amount?—This point is at once set at rest by turning back to the report of the referees. At page 14 those gentlemen state as follows:—"We estimate from our investigations that the total volume of sewage discharged in twenty-four hours in dry weather on the north side is 11,513,227 cubic feet, and that the total volume on the south side is 3,736,550 cubic feet." This is merely to show that the figures on which Messrs. Hofmann and Witt based their calculations for the total value of the sewage was the dry weather flow.

1740. Did they base their calculations on the dry weather sewage?—They took that figure simply because they had no other; but that does not express the real quantity of the sewage.

1741. Would the sewage with the rainfall be worth as much as the sewage which they took for analysis?—At page 14 of the report of Messrs. Hofmann and Witt, will be found the analysis of 15 specimens of sewage taken by them from different sewers, and at different times. It will be found that the sewage taken in wet weather is invariably richer than in dry weather. At page 15 they state, "The preceding table gives the results obtained at different times at the Falcon-brook sewer, the Earl sewer, the Fleet sewer, the King's Scholars' Pond sewer, and the Northumberland-street sewer, the experiments being made partly under ordinary circumstances, and partly after heavy rains which, as has been pointed out already, induce an abnormal condition in the composition of the sewage. The table shows that the variations in the composition of the sewage water are very great, indeed, not only at the different hours of the day, but also at different seasons, the minimum quantity of solid constituents being as low as 44·14 grains (in the Falcon-brook sewer); whilst on one occasion, after the thunderstorm in the night of Friday, 19 June 1857, the total solid matter in the Savoy-street sewer rose to 296·97 grains in the gallon, of which 188·49 were mineral, and 108·48 organic matter."

1742. Then, are you of opinion that the storm sewage is richer in manurial powers than the dry weather sewage?—The analysis proves it, and the referees draw particular attention to that fact at page 17. They state, "To determine the quantity of water from rain with which the sewage should be diluted in the suburban districts, it was necessary to obtain a knowledge of the effect of rainfall in diluting the sewage, and we consequently caused samples of sewage to be taken during rain, when the violence of the sewage exceeded a certain amount. The peculiarly dry spring which we have experienced, although favourable to the general results of our guagings, has been unfavourable to the determination of the question of dilution. It appears, from the samples obtained, that during the periods of drought a very large amount of deposit takes place in the smaller

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smaller sewers and branches, and that this deposit is wasted out by degrees during periods of rain." The referees show clearly that the sewage is very much richer in wet weather than in dry weather.

1743. Then how is it that you establish the value which you ascribe to the sewage in your tender and in the papers which have been laid before the Committee?—I establish the value of the sewage in the first place by shewing that in the sewage of London there is a certain amount of guano, and I then proceed to ascertain what is the real annual amount of the sewage, and in that way I establish what is the annual value of the London sewage as shewn by analysis.

1744. Assuming that Messrs. Hofmann and Witt are correct in their estimate that 1,250 tons of sewage contain one ton of guano, supposing those 1,250 tons to be dried, what would be the fertilising value of the sewage of the metropolis in one year?—That must depend upon the amount. I have failed as yet to get the exact quantity of the metropolitan sewage. The referees base their calculations upon a flow of sewage equal to seven cubic feet per day, and Mr. Bazalgette bases his on a flow of five cubic feet per day.

1745. Then you would have to add the rainfall to that, would you not?—Yes; I should have to add the rainfall to that. I calculate that the area drained by the metropolitan sewers amounts to 108 square miles, and that the total rainfall in the metropolis would amount to 169,683,510 tons, taking 25 inches to be the average rainfall.

1746. But taking the seven cubic feet as your basis, and taking the population of the metropolis at 3,000,000, what would be the amount of the sewage without the rainfall?—217,762,650 tons per annum, and to this I have to add the rainfall. I do not add the entire of that rainfall, because I think a certain amount will be lost in a variety of ways, but I add two-thirds of it.

1747. Mr. Hemans in answer to question 523 stated that the rainfall was immaterial, being so small in quantity in comparison with the amount of sewage; what is the amount of rainfall on the metropolitan area?—I believe it is generally assumed to amount to 25 inches in the year.

1748. Then 25 inches per annum on 108 square miles would be 55,772,933 cubic feet per mile, would it not?—I have not run it out to the mile, but I have taken the total on the whole area which would be 169,683,510 tons.

1749. Would all this rainfall run into the sewers or not?—I think about two-thirds of it would.

1750. What would become of the other third?—It would be lost by evaporation, and in various ways.

1751. By this corrected amount of rainfall, what would the total of the diluted sewage amount to?—To 330,884,990 tons per annum.

1752. What would be the amount of guano in that?—It would contain 264,708 tons of guano.

1753. And what would be the value of that, supposing it were extracted and dried, and taking guano at 11 *l.* a ton?—£. 2,911,788.

1754. Is 11 *l.* per ton the price of guano at present: it is the price mentioned by Messrs. Hofmann and Witt?—It was then selling at 11 *l.*, but it is now 13 *l.* 2 *s.* 6 *d.* per ton.

1755. Are you sure that that is the correct price of it?—Yes; I sent to Mr. Lawes's office, and got his price-list for this month. I find he states that Peruvian guano in dock, shipped and invoiced on the gross weight, is 13 *l.* 2 *s.* 6 *d.* per ton.

1756. Then what would be the value of the sewage at that price?—It would be 3,474,292 *l.* 10 *s.*

1757. Is that the amount of guano in the metropolitan sewage in a year, on the supposition that it is seven cubic feet per person?—Yes.

1758. If you take Mr. Bazalgette's estimate of five cubic feet per person per day, how many tons would there be per annum?—Of sewage proper, there would be 155,544,750 tons per annum.

1759. And adding the rainfall to that, what would it be?—Adding two-thirds of the rainfall to that would make 268,667,090 tons.

1760. And how much guano would there be in that?—It would contain 214,934 tons.

1761. And what would be the value, if that were extracted and dried, at 11 *l.* a ton?—2,364,274 *l.*

1762. And at the present price of guano what would it be?—2,821,008 *l.* 15 *s.* 0 *d.*

1763. In your calculations you neither take the basis of the referees in the Report of the Metropolitan Drainage, nor that of Mr. Bazalgette; do you base your calculations on a smaller amount than either of those, and if so, why do you do so?—My reason for taking a smaller amount was, that I found upon inquiry at the Board of Works that the outfall tanks of the Board would not contain the amount of sewage that I found Mr. Bazalgette's calculations would reach, and, therefore, I based my calculations on the maximum content of the outfall tanks.

1764. Then what is the amount of sewage that you take?—266,052,441 tons per annum.

1765. What would be the amount of guano in that?—It would contain 212,842 tons.

1766. And what would be the value of that at 11 *l.* per ton.—It would be 2,341,262 *l.*

1767. And at the present price of guano what would it be?—2,793,551 *l.* 5 *s.*

1768. At page 121 of the Report of the Metropolitan Board of Works do you state that the annual volume of the sewage on the north side is 168,033,115 tons, and that that, at 500 tons per acre, would irrigate 525 square miles?—Yes.

1769. That will be equal to 336,066 acres, will it not?—Yes.

1770. How much guano would there be in the sewage on the north side?—There would be 134,424 tons.

1771. And what would be the value of it at the present rate?—1,764,345 *l.* 5 *s.*

1772. Are you aware that Messrs. Napier and Hope put in a tender for the sewage of the north side of the metropolis?—Yes.

1773. Have you seen their letter of 29th April 1864?—I have a copy of it.

1774. Will you look at page 20 of that letter, and read the passage which is marked?—"From these various sources, it appears that the theoretical value of the manurial constituents of sewage is, on the average, 6 *s.* per annum per head of population; but this is the value calculated as if the several constituents were in the most condensed, portable, and economic form; and we have seen that in sewage, on the contrary, they are presented to the ordinary farmer in a most objectionable form. The question is, then, how to apply the sewage, and what crops to apply it to, so as best to realise the theoretical value; and this, it is evident, is a very complicated question. A supply of liquid sewage, amounting to 10,000,000 cubic feet *per diem*, is not a thing that can be sold in the market like guano, superphosphate of lime, or ulmate of ammonia. These are condensed and portable; they can be easily housed and stored at seasons of the year when the demand is slight, and can be transported economically and profitably to the most distant parts of the country. But the enormous volume of water with which sewage is diluted alike, forbids the possibility of storing it, and of distributing it over any great extent of country, or by any ordinary means of transport. Each day's supply must be sold and disposed of in the 24 hours. It must also be made the vehicle for its own distribution. The notion of conveying 10,000,000 cubic feet, or 277,777 tons daily in covered waggons by railway, as has been proposed, will not bear serious consideration. The difficulties, therefore, of realising the theoretical value of sewage are very great, and the same authorities who estimated this at 6 *s.* per head of the population, doubt whether more than 1 *d.* a ton can practicably be realised from its application to the soil, which is considerably under its theoretical value. Thus, taking the population of the northern area of from 1,700,000 to 1,800,000, the theoretical value of the manurial constituents of the sewage would be from 510,000 *l.* to 540,000 *l.* per annum; while the realisable, that is, in other words, the net value of 10,000,000 cubic feet per diem at a penny a ton, would only be 422,452 *l.* 10 *s.* 5*d.*, showing a loss of some 20 per cent., made up partly by actual loss, but chiefly, of course, by the cost of application."

1775. There is a very considerable difference between their estimate of the value of the sewage on the north side, and your estimate; how do you account for that great difference?—They base their calculations entirely upon the value of the excreta of the inhabitants, and they take 6 *s.* per head per annum as the value, but that figure is incorrect.

1776. Is that too low an estimate?—Quite too low, but certain parties who have an interest in running down the value of sewage invariably take that figure.

1777. Supposing that it were 6 *s.* per head that would be 3,000 *l.* per annum for every 10,000 of population, would it not?—About that.

1778. If you take the rateable property of England and Wales at 68,000,000 *l.*, and the population at 18,000,000, that would be 4 *l.* per head of rateable property for each person, would it not?—Yes.

1779. Then the 6 *s.*, which you say is too low, would represent a rate of 1 *s.* 6 *d.* in the pound?—Yes.

1780. Messrs. Hofman and Witt estimate the value of sewage at 10 *s.* 10 *d.* per person, per annum, do they not?—At pages 50, 51, and 52 of their analysis, they give the calculations of the money value of the excreta of the entire population of London based on the analysis of Professors Way, Liebig, Wesarg, and others, and the result as they bring it out is 10 *s.* 10 *d.* as the annual value of the excrement of each person.

1781. By a return lately laid upon the table of the House of Commons, (No. 209 of 1864) the whole amount of property and income-tax is 10 *s.* 3¾ *d.* per head of the population of Great Britain and Ireland; at that rate would not the sewage of Great Britain and Ireland more than pay the income and property-tax?—That is merely the excreta; to that has to be added the other fertilizing matters that enter the sewers.

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1782. If you take it at 10 *s.*, the population being 29,203,836, would not the value of the sewage be 14,601,918 *l.*?—It will be.

1783. According to Return 437 of 1862, the total amount of local taxation, highway rates, and church rates, sewer, harbour, and poor-rates, and other rates, is 14,855,122 *l.*, is it not?—I believe so.

1784. Therefore the sewage would be equal to the total local taxation of England, Ireland, and Scotland?—The excreta would, without the additional matter.

1785. Assuming the sewage on the north side to be 168,033,115 tons a-year as you have stated; would that, at 500 tons an acre, irrigate 336,066 acres?—Yes.

1786. How much guano is there in that 500 tons of sewage if extracted and dried?—I think about eight cwt., worth, at the present rate, about five guineas.

1787. How much guano do farmers generally use; is it not about a ton for seven acres?—That depends upon a variety of circumstances, such as the natural richness of the soil. I am not prepared to say exactly what is the amount.

1788. What would be the value of the 500 tons of sewage, if extracted and dried, taking the guano at 11 *l.* per ton?—About 4 *l.* 8 *s.*

1789. It appears from your letter in this book which is before the Committee, that you propose using the sewage in addition to other manures. Is that so?—We must do so; it will only be purchased in addition to the other manures, to supply the want of manure.

1790. With regard to the amount of fertilsing matter, will you read and explain what you have written at page 115 and 116 of that book?—"Now, if we assume for a moment that all the land included within the area proposed to be irrigated with the London sewage is farmed in the best manner, according to these three systems (they being the best known), and self-supporting, we find that we would require on an average over 780 tons of sewage per acre, = a depth of 7·7 inches, in addition to all the manure that could be produced on the land. But this would not be a correct assumption, as a large proportion of the land within the area would be found to be cultivated on other systems not so manure-producing, and therefore requiring more sewage, and this more particularly would be found to be the case on permanent grass-land. It has been found that grass-land will absorb enormous quantities of sewage, making returns in proportion to the manure it receives." That is a mistake, I have since ascertained. When I wrote this, I did not know so much about sewage as I do now. "Now, if we divide the entire area that is to be irrigated by the London sewage, thus say two-thirds under tillage requiring 780 tons of sewage on an average per acre, and one-third under permanent grass; of this one-third, two-thirds will be under grazing, requiring 1,000 tons per acre, and one-third under meadow requiring 3,000 tons per acre. This would give us as the general average (over the entire area), 2,186 tons of sewage to the acre=a depth of 1·8 feet, provided that sewage alone was used in addition to the farm-yard dung. But such would not be found the case; other manures would still be used as well as sewage. It is not by any means probable that any one manure could fill the place of all others, nor would it probably be good for the land that it should; but inasmuch as sewage contains the component parts of most other manures, and as it can be applied at all periods of the growth of the plant, while no other manure

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manure can, and especially in hot summers when a copious use of sewage would produce almost a tropical growth, it is more than probable that, on any area where sewage could be had at a reasonable rate, it would supply at least two-thirds of whatever manure was required to be purchased, or a general average of 1,457 tons per acre=a depth of 1·2 feet. But to allow a margin for undrained lands &c., &c., let us again reduce the average quantity to, say 1,000 tons to the acre over the entire area. As, however, I consider that it is desirable in the interest of the company to keep the supply of sewage well under the demand, and thus to secure a good price for the article, I have made my calculation for an area of such extent as only to afford an average supply of 500 tons to the acre =a depth of 4·9 inches, which, as it will be applied not in one dressing but spread over several, cannot possibly be injurious or even offensive to the public."

1791. It appears from that, does it not, that you consider that a greater amount than 500 tons an acre should be applied to the land?--That was written some years ago; I am since of opinion that a smaller quantity would be required.

1792. Do you think that 1,064 tons would be too much?—I think I could not get the value of the sewage from the farmers, if you consider that in 500 tons there is not five guineas worth of manure.

1793. Do you mean that the extra crops would not pay for it?—I fear that, as a general average, it is so large a quantity of manure that you could not expect to sell it with advantage.

1794. You state now that what you have said there about the grass was a mistake; do you consider then that the sewage is equally applicable to every kind of crop?—The evidence taken before the Select Committee proves that it is.

1795. But there is some evidence of Professor Way's in answer to questions 773 and 774, put by the Committee of 1862, from which it appears that there is a sort of balance, and that sewage is better for grass land, while the artificial manures are better for the other crops; do you not agree with that?—No; no manure is of any value whatever to land until it is liquified; if we do not liquify it before we apply it to the land it remains dead upon the earth; it must be liquified by rain before it can be of use.

1796. Then do you differ from Professor Way when he states that manure is of no value until it is extracted and dried?—He is not borne out by the evidence.

1797. What evidence have you in favour of your opinion?—I am afraid to answer that question, as in support of my opinion I should have to read a great many extracts.

1798. Do you base your opinion upon the evidence taken before the Committee of 1862?—Clearly.

1799. Then do you hold that the effect of sewage in a liquid state is greater than when it is extracted and dried?—The evidence proves that it is quadrupled in effect.

1800. You have given us the estimate of the value of the sewage extracted and dried, have you not?—Yes.

1801. If you intend to apply it in a liquid state, and if you state that its properties are four times as great in that state than when it is extracted and dried, you will have to correct your estimate, will you not?—The real value of the sewage delivered to farmers on their fields will unquestionably be greater than would be expressed by the value which I have given of the manure when extracted and dried.

1802. But the commercial value of your plan depends chiefly upon the cost of carrying the sewage from the different towns to the country, does it not?—That would be a main item.

1803. Is it not much more expensive to carry a bulky article than to carry a small article?—That depends upon the kind of article. Fluid will carry itself to a certain extent; there is nothing which we can convey so cheaply.

1804. But when you speak of the value of the sewage being increased by its being dissolved, do you mean that supposing you had it already in the country its value would be increased by its being dissolved?—Precisely; supposing I had it delivered on the fields of the farmers and ready for use to apply it whenever they chose.

1805. Do you mean that the carriage of any substance in suspension in water is cheaper than its carriage in any other way?—Clearly; it is a question merely of pumping the water.

1806. But the 1,250 tons of sewage contain a ton of guano; would it be cheaper to cart it or to convey it as liquid sewage?—It would be much cheaper to convey it as liquid sewage.

1807. Are you borne out in that opinion by engineers?—Yes; nothing can be more clearly proved than the cost of pumping.

1808. If it is the case that the power of transporting matters in suspension is cheaper than any other mode of transport, might not artificial manure also be transported by means of the sewage itself as the carrier?—I think that in cases where the sewage is at present very much diluted, by adding a little artificial manure to it we could bring it up to such a strength as would pay for utilising it by steam-power.

1809. A letter of Baron Liebig was published a short time ago, in which he stated that the value of the sewage would be doubled if there were phosphates in it; would the value be increased by that means?—Clearly so.

1810. Then the value of the sewage would be greatly increased, although the price of transporting it would not differ?—Yes; and we could also change the character of manure year by year.

1811. Would the phosphates be held in suspension, or be dissolved? — They would be dissolved; that would of course be the province of the chemist who would be appointed by our company, but not being a chemist myself I do not enter into that.

1812. You propose to apply a very moderate quantity of sewage to all the different crops, do you not?—Yes.

1813. Do you suppose that the farmers could pay the price of the sewage out of the extra crops, which would result from such moderate dressing?—The results obtained by the use of a moderate amount of sewage, especially by Mr. Miles, of King's Weston, near Bristol, have proved that the small dressing would render it very profitable matter to the farmers.

1814. Have you read the second report of the Royal Sewage Commission?—I have.

1815. Have you seen there the tables of Mr. Lawes, and the report of the quantity of sewage which he has applied at Rugby?—Yes.

1816. Do you consider those tables, and the results that he has arrived at, to be correct?—I consider them to be entirely wrong; and I think that any one with the least pretensions to science would

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would know that they were wrong. In support of that opinion, I would ask to be permitted to read, from the examination of Mr. Way, his answers to two or three questions. The whole question of sewage utilization turns simply upon the power of the earth to extract from the liquid the manure that it contains; and if you put more sewage on the earth than the earth can deal with profitably, you are throwing it away. At page 36 of the first report of the Select Committee on the Sewage of Towns, at question 776, Professor Way is asked, "You have made experiments on the power of soils to absorb the manure contained in sewage?—Yes. Will you inform the Committee what were the results obtained by you?—The results generally were these: that in soils there resides a power which, previously to my examinations, I believe was not recognised, to separate from liquids containing manure, containing ammonia, for instance, and potash, and phosphoric acid and magnesia, that is to say, all the important elements of manure, these elements; to separate them from water, not by mere filtration, because these things would pass through a filter, but by the peculiar chemical attraction possessed by the ingredients of a fertile soil for these liquids, so that if we were passing a liquid containing manurial matters through a given quantity of soil, the water would pass through, and these matters would be retained and fixed in the soil. I look upon this as a great arrangement and provision of nature for the preservation of manuring principles from being washed out of the soil by rains;" and the limit of that power is also explained by Mr. Way, in answer to further questions which were put by Mr. Ayrton. At question 940 he is asked, "Can you apply the sewage with advantage to a low land, with a view to the growing a wheat crop afterwards?—I think you could do perfectly well in small quantities, not to deluge the land. You could do it almost as well, as you could apply it to the young wheat, I believe.—Do you think that it would have a sensible effect upon the produce of the land?—Yes, from the fact that it is not the plant, but the soil which looks after the interests of the plant: the soil is engaged in abstracting from liquid manure the constituents which make it valuable.—Could you in that way, to any extent, get over the difficulty of applying the liquid sewage to the young plant, by applying a sufficient quantity of sewage to the land before it was planted?—Yes, but you cannot go beyond a certain point in that way, or the power ceases." Now, I think that when the absorptive power of the earth is limited, it is clearly absurd to put such quantities of sewage on the land as it cannot deal with; it must be put on at a loss.

1817. Do you mean to state that Mr. Lawes has not correctly stated in that book the results at which he arrived?—I mean to say that he states that the produce was in direct proportion to the quantity of sewage applied, and science proves that that statement cannot possibly be correct, because there is a limit, and that limit is very soon reached, and if you pass it you get no further benefit from the manure; therefore this statement of Mr. Lawes's cannot possibly be correct.

1818. But he gives the exact amount of sewage applied, and the grass grown, and the yield of milk, does he not?—Yes.

1819. For every 1,000 tons of sewage which he used he recovered only between 5 *l.* and 6 *l.* in crop, so that the value of the sewage would be 1¼ *d.* a ton?—It would not prove the value of the sewage, it would only prove what was the value of the grass which he stated that he recovered.

1820. Then would you recover the same amount of grass with half the amount of sewage?—The evidence of Mr. Westwood, the farm bailiff of the schools at Anerley, proves that; he applied the sewage of that establishment over four acres of Italian rye-grass; two acres of that were supplied by gravitation, and over those two acres from 8,000 to 9,000 tons of sewage were allowed to flow.

1821. Then do you consider that you would get as good results as Mr. Lawes got if you applied only 500 tons an acre?—Very nearly; Mr. Westwood obtained as good a return from 1,500 tons as from 9,000 tons; there was no difference he stated in the crop.

1822. But you only apply 500 tons, do you?—That is an average. I am now speaking of a particular crop, which is generally largely supplied with sewage, viz.:—Italian rye-grass.

1823. You might put a less quantity than that on certain crops, and more on others, might you not?—Yes; I may draw the attention of the Committee to a specimen of wheat, grown by the Rev. Dr. Booth on very poor land, which had received no manure for 20 years, except a little sewage the year before this wheat was sown; it is over six feet high.

1824. Now as to the plan of distribution for the utilisation of those 266,052,441 tons of sewage, at 500 tons an acre, you state that you require about 532,000 acres; is that so?—Somewhere about that.

1825. Yet your works extend over twice that amount, do they not?—They do.

1826. With what object is that?—The reason is that on such an area there would be a large portion of the ground taken up with roads, water, buildings, ornamental grounds, and other places.

1827. Do not your works extend over 1,680 square miles?—Yes.

1828. That is equal to 1,075,200 acres, is it not?—Yes.

1829. And the estimated cost of your works will be under 3,500,000 *l*?—In a rough estimate that would be about it, I think.

1830. Do you not state that you would give the ratepayers half of the profits, and that by that means you would ensure their obtaining no less than 700,000 *l.* per annum?—Much more than that eventually; they get half the profits, whatever they are, after paying the working expenses. That estimate was sent in in 1861. I then asked for a preference dividend of five per cent., which I do not ask for now.

1831. Is the sewage received by you in those outfall tanks which you have spoken of?—Yes.

1832. Are those constructed by the Board of Works?—Yes.

1833. You do not propose to construct them at all?—No.

1834. What will be the size of those tanks on the north side and what on the south side?—Twelve acres, by 15·5 feet deep, on the north side, and seven acres, by 15·5 deep, on the south side.

1835. Those contain the sewage of 12 hours only, do they not?—That was the information which I received. At particular periods of the tide the sewage is to be allowed to escape into the river.

1836. Does not that limit you as to the amount that you have to pump in 12 hours?—Not exactly; if the Board of Works allow me to make use of this

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this reservoir, by continually pumping the sewage as I proposed, there would be no necessity to allow any of it to go into the river, because I would always keep it down.

1837. Then you must at all events pump that amount of sewage in 12 hours?—We would pump the 24 hours' supply in 24 hours; the flow in the daytime is much heavier than during the night.

1838. What would be the contents of the north side tank, taking the size you have given?—It would hold 8,102,160 cubic feet.

1839. Is that what you intend to pump in 12 hours?—Not exactly; that would be the contents of it, but I should be continually pumping.

1840. Do you calculate upon being able to pump that amount in 12 hours, or in what time?—The calculation was to pump it in 12 hours, because I did not know what arrangement the Board would force upon me. If the Board allow me to use their tanks, I shall not require so much horse-power, but if I have to pump it in 12 hours, I shall, of course, have to use more horse-power.

1841. How high do you propose lifting it up? —This estimate is based upon the assumption that it will be lifted 460 feet, but I believe that it will not be necessary to lift it more than 300 feet.

1842. Do you intend to pump it up to Hampstead?—No. In making this estimate I fixed Hampstead as a point for calculation merely.

1843. That is 430 feet, is it not?—Yes, but to allow for correction, and for wells, and so on, I made it 460 feet.

1844. What amount of horse power would be required to lift that amount of sewage in 12 hours to that height?—The net horse power for the north side would be 9,985·5.

1845. The contents of the south side tank are how much?—4,726,260 cubic feet.

1846. To what height do you propose to lift that in 12 hours?—That was assumed to be lifted to the top of Shooters hill, which is 412 feet, but which I called 440 feet in order to meet correction.

1847. What net horse-power do you propose for that?—5,570·1.

1848. Then the total net horse-power on the two sides would be 15,555·6, would it not?—Yes.

1849. How much would that be in gross horse-power?—They allow for friction and spare power 15-8ths of the net horse-power, that would amount to 29,167 gross horse-power.

1850. What is the average price for erecting buildings, and steam engines and pumps per horse-power?—I applied to Messrs. Hocking and Loam for an estimate, and they gave me 40 *l.* per horse-power on the gross; that would amount to 1,166,680 *l.*, that is, I may say, greatly in excess of the real amount. In all these calculations I assume everything against myself, that I may not be accused of making a fancy estimate.

1851. From the outfall tanks which belong to the Board of Works how do you conduct the sewage to your engines?—I allow it to pass through covered aqueducts into wells, and from those wells it will be pumped up to the summit reservoir.

1852. You propose to have gratings in the aqueducts; for what purpose are those gratings? —Those are to catch all floating and other matters in the sewage.

1853. Before you get the sewage into those outfall tanks, has it been lifted already by the Board of Works?—Yes, about 40 feet.

1854. Then there could not be anything in the sewage that would injure the pumps?—There might not be, perhaps, anything that would injure the pumps, but in order to prevent any accident, I propose to have additional gratings.

1855. Do you propose to clean out those gratings every now and then?—They would be made in duplicates, or in sets for that purpose.

1856. Would those aqueducts be covered?—Yes, all the works would be covered.

1857. You have not mentioned the price of the aqueducts, and you do not mention the length of them; can you state those particulars?—The aqueducts would be very trifling.

1858. Would they be very short?—Very short.

1859. You would use Cornish engines, would you not?—Yes, Cornish engines.

1860. After leaving the engines do you propose to force the sewage through three mains on the north side, and two mains on the south side?—Yes, I divide them into sets to make the pipes of a more reasonable size.

1861. What is the rate of flow of the sewage that will be forced through those mains?—I assume that we shall pump it at the rate maintained by the Water-works, which is about 2½ miles an hour.

1862. (To Mr. *Bowing.*) How do you arrive at the necessary bore for those mains after leaving the engines?—I have assumed a rate of flow in the mains of 2½ miles an hour, which is the usual rate maintained in the water works systems. Then I allow x to be the bore of the main, and I know the rate of flow, and I know the quantity of the sewage, so that it is easy to work it out by making an equation of it.

1863. Do you mean that you divide the volume of the sewage by the rapidity of its flow?—Clearly.

1864. What does that give you as the area of all the mains together on the north side in square feet?—51·15 square feet; and if there were three mains it would be 17·05 square feet for each main. Then the diameter would be 4·66 feet.

1865. What is the distance from the outfall tank on the north side to Hampstead?—It is here assumed to be 13 miles.

1866. Then as there are three pipes, you would calculate, would you not, that there are 39 miles of main 4·66 feet in diameter?—Exactly.

1867. On the south side there are two mains. What is the distance from Plumstead to Shooter's Hill?—Four miles.

1868. And what is the diameter of the mains? —4·36 feet.

1869. Then that would be eight miles of main of 4·36 feet in diameter, would it not?—Yes.

1870. What would be the price per ton for those mains?—I have computed the weight of the whole, and I take it at so much per ton; it would be 63,842 tons, which, taken at 5 *l.* 10 *s.* per ton, would give 351,131 *l.*

1871. And what would be the cost of laying it? —The cost of laying, at 2 *l.* per yard, over 82,720 yards, would be 165,440 *l.*

1872. Then what would be the total?—The total cost would be 516,571 *l.*

1873. On the north side you have a reservoir at Hampstead Hill, and on the south side at Shooter's Hill, have you not?—Yes.

1874. And you have to raise the sewage to those places?—Or to elevations equal to those.

1875. What is the content of those reservoirs? —That on the north side is 16,204,320 cubic feet, and

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and that on the south side is 9,452,520 cubic feet.

1876. That is more than the cubical contents of the outfall tanks, is it not?—Yes; this is equal to twice that.

1877. Why have you made that difference?—I took it in order to be quite safe. I do not know how we might have to act with reference to the outfall tanks.

1878. Then would the reservoir in fact contain the sewage of 24 hours?—Yes exactly.

1879. They are cylindrical, are they not?—That I have not specified, but in speaking of the reservoirs themselves, I have merely said, that in order to get at the cost of making them I would take a content equal to the cubical content assumed, and then encircle the whole with a foot and a half of brickwork.

1880. Are they below the surface of the ground?—As is usual the half of the content would be excavated, and what is got out would be used as an embankment for the other portion; but not knowing the size I have merely taken the maximum content, using it in any shape, but I have assumed that the cylindrical shape will be adopted.

1881. How many acres do the two reservoirs cover?—By the assumption here it is 19·6 acres in all.

1882. Would the brickwork of a foot and a half thick be strong enough to contain that body of liquid?—I have merely taken that to get at the cost.

1883. Would the reservoirs be covered?—They would be covered.

1884. You have put down as the total cost of the reservoirs 132,080 *l.*, have you not?—I have.

1885. Does that include the land on which they stand?—I have supposed it to include that.

1886. Mr. Hughes, in his book on water-works says, p. 291, that the cost of covered reservoirs varies from 30 *s.* to 3 *l.* per thousand gallons of capacity, and that the cheapest reservoir which was built, was at Wolverhampton. That reservoir contains 1,500,000 gallons, and the cost, exclusive of land, is said to have been 2,200 *l.* He says that a reservoir to contain 2,000,000 gallons would cost 4,162 *l.*, so that it appears that a reservoir costs about 2 *l.* for every 1,000 gallons. Taking that statement of Mr. Hughes's into consideration, do you not think that your's is rather a small estimate?—I believe that the estimate which I have given here is far too small for content of the reservoirs, but I believe that it is not too small for the content that we shall require. I wish the Committee to understand that this estimate is got by taking an assumed content very much greater than will be required. Without going into the details of the puddling, concreting, and so on, I lumped it altogether by taking it all as being enclosed within a foot and a half of brickwork.

1887. Then do you not think that this is rather a small estimate?—I knew it to be so at the time, for the dimensions stated.

1888. How are the reservoirs to be covered?—I have supposed that they shall be covered with brick.

1889. Is not your estimate very much too small for that?—No; I believe that it is not too small for the reservoirs we should actually require.

1890. The sewage flows from those reservoirs by gravitation, does it not?—Yes.

1891. How much sewage is to flow through the reservoir on the north side in the 24 hours?—I have assumed it to be 16,204,320 cubic feet in 24 hours.

1892. On the south side how much would flow through the reservoir?—On the south side I have assumed 9,452,520 cubic feet.

1893. Would the works of distribution extend over 1,680 square miles?—Yes.

1894. Do you divide that into 1,050 square miles on the north side, and 612·4 square miles on the south side?—Exactly.

1895. Why do you make the area on one side to be five-eighths of a circle, with a radius of 23·1 miles, and on the south side to be three-eighths of a circle with a radius of 22·8 miles?—Because I assume it to be impossible to apply the sewage over the whole area. There is a mistake here in the printing, it ought to read, "east and south-west," instead of, "east and south-east."

1896. Why do you take five-eighths of a circle on the north side, and three-eighths of a circle on the south side?—The area included would, of course, be five-eighths on one side, and three-eighths on the other; but such a division is merely to avoid the river, houses, &c.

1897. What would be the fall through the mains from the reservoir?—The fall is one of the most difficult items to find in this estimate, and it gave me the most trouble. I took a height of 460 feet on one side, and 440 on the other; and I knew that the area we were computing for would be 23·1 miles in radius on the one side, and 22·8 on the other. I supposed then the fall to be an average one, and that would give 20, not meaning by that, that the fall literally would be 20 feet in a mile; but that was as near as I could get at it.

1898. Are the mains laid below ground?—They are laid below the ground.

1899. And you have no other reservoirs than those two?—None.

1900. How many miles of main do you put to each square mile of country?—On an average, one mile of main to each square mile of country.

1901. You divide the area into concentric circles. With what object is that done?—In order to approximate to the amount that might be taken out of the mains in any specified time.

1902. And then you have different sizes of mains in those different areas, have you not?—Yes.

1903. In the sixth area on the north side, the size of the main is ·9 of a foot, is it not?—Yes.

1904. Does that feed 264 square miles of country?—That is what is supposed.

1905. But then the first main on the north side is 2·02 feet in diameter, is it not?—Yes.

1906. That feeds only 31·4 square miles of country?—Yes.

1907. Why do you have a larger main to feed a smaller area?—The large main feeds its own and the successive areas as well.

1908. Then do you mean that the sewage flows through that large main right on to the outside area, and feeds the country on its passage?—That is the supposition. I suppose the main in each of those areas to supply its own area and the areas coming after.

1909. What will be the total weight of all those mains?—The total weight of the whole would be in tons 664,375 tons.

1910. And that at the same price as you have given

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given already, namely, 5 *l.* a ton, would be how much?—3,321,875 *l.*

1911. What would be the price of laying?—£. 731,456.

1912. What would the total be?—£4,053,331.

1913. To Mr. *Ellis.*] You propose to do as the water companies do, and merely to lay down your mains, and then let your customers lay down their pipes to their own premises?—Precisely; I merely copy the Water Works.

1914. Have you a meter for measuring the amount of sewage that they take?—There will be a meter placed at the entrance of each farm, and between the pipes of the company and the pipes of the farmer the sewage will be measured.

1915. Would you propose to distribute this sewage by hose and jet?—That will rest entirely in the discretion of those using it. I deliver it to them under pressure, and they may apply it by hose and jet, or allow it to escape from the hydrants into carriers, but I do not approve of that plan.

1916. How much would it cost per acre to lay down those pipes on the farms?—It has been worked out at great length in the report of the Board of Health to be between 3 *l.* and 4 *l.* for permanent pipes.

1917. Would you propose having canvas pipes; would that be cheaper?—The farmers may use movable pipes, if they choose; and, where the pressure is not very great, I think they might be able to use strong earthern pipes, which would be cheaper than iron.

1918. To Mr. *Bowing.*] With regard to those 29,167 horse-power engines, what would be the working expenses of them?—That is the gross horse-power, though two-thirds of that is assumed to be the working horse-power, and that is 19,445. That is assumed to be worked at 15 *l.* per annum per horse-power; that will give 291,675 *l.*

1919. What would salaries, and rent, and all such things amount to?—£. 15,000.

1920. What would be the total cost of working?—£. 332,125. That is including an item for deodorisation of about 25,450 *l.*

1921. To Mr. *Ellis.*] Do you consider that deodorisation necessary?—Not at all; but I did not know whether the Board of Works would compel me to deodorise the sewage, so that I included it in my estimate.

1922. You do not think that deodorisation is necessary?—It is quite useless. The sewage flowing from the outfall sewer has merely the smell of damp cloth; it is not at all offensive.

1923. (To Mr. *Bowing.*) Then, it appears that the cost of erecting your works for engines, pumps, and buildings, is 1,166,680 *l.*; for mains &c.; 516,571 *l.*; for reservoirs and wells, 132,080 *l.*; and for the distributing mains, 4,053,331 *l.*; making, in all, 5,868,662 *l.*; is not that so?—Yes, that is it.

1924. And your working expenses, per annum, amount to 332,125 *l.*, do they not?—Yes.

1925. What would be your revenue for the amount of sewage which you have estimated for, if you sold it at 2 *d.* a ton to the farmers?—£. 2,217,104 a-year.

1926. Deduct the 332,125 *l.* for working expenses; what would that be?—That would leave 1,884,979, or 30·4 per cent. on a capital of 6,200,787 *l.*; which is, however, in excess of the amount required for the works, by 2,000,000 *l.*

19 7. How much of that would you give the ratepayers?—One-half of whatever is received, after paying the working expenses.

1928. (To Mr. *Ellis.*) There is a passage in page 73 of this book, which you will, perhaps, explain: "The extent of my area is so large, that the greatest average quantity of sewage per acre that can be applied is 500 tons, or 4·9 inches in depth." Why do you make the extent of your area so large that you cannot apply more than that?—I do not think that we could get the value of the manure off a smaller area than I have chosen. I think it is scarcely large enough. My object was to get the highest price that I could for the manure.

1929. Do you think that the sewage could be applied during frost?—Certainly not.

1930. Then, what would you do during the frost?—I must deodorise it, and then let it escape into the river.

1931. Do you propose to erect deodorising works?—I consider that no great works would be necessary; Dale's deodorising fluid would be amply sufficient for my purpose.

1932. Supposing the landowners, or the farmers did not choose to have this sewage, what would you do?—In that case the thing would be a bad speculation; but we know that at present there is a great want of manure, and, I think, I am right in assuming, that if we bring manure within reach of the farmers, they will purchase it at a reasonable price.

1933. Have you made any alterations in your plans since 1861, when you first tendered?—None whatever.

1934. Nor in the terms you offered?—None; except that I offer now more than I did then. I at first wanted a preference dividend of 5 per cent., but I do not now want that preference dividend.

1935. Did not the Board of Works write to you for further information on November 16, 1861?—Yes; I received a letter from the Board of Works demanding further information.

1936. Did you comply with that request?—Certainly not.

1937. Why not?—Because the information which they required, engineering, geological, and otherwise, could not possibly have been got up under an expenditure of 2 *s.* 6 *d.* an acre. There are 640 acres in a square mile, and 1,680 square miles in the works; consequently the information would have cost about 134,400 *l.*, and it would have been totally useless when furnished.

1938. Had they already come to a decision at that time with regard to one of the plans?—Yes; the reports, published by the Board, proved that. The date of this letter, asking for this information, is the 16th of November 1861, and in my hand I hold a report of Mr. Bazalgette, the engineer, and Mr. Smith, the solicitor to the Board; the engineer states, in his report, which is dated the 5th of December 1861, "In pursuance of the order of the Main Drainage Committee of the 12th November last" (that is four days previously to the date of this letter to me) "and the 10th instant, I have considered the engineering features and estimates of the works contemplated in the proposition submitted to this Board by the Hon. Wm. Napier and Mr. Wm. Hope, V.C., for a concession of the sewage of the northern area of the metropolis for a period of 50 years, upon certain conditions to be approved by the Board." From that it appears, that four days previously to writing this letter to me, the Main Drainage Committee had come to the conclusion of granting the concession to Messrs. Napier & Hope.

1939. Could

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1939. Could you raise the capital if you had a concession at a fixed annual rent?—Certainly not; it would be an utter impossibility.

1940. Would you then propose a rent of so much per ton?—That would be equally impossible; no one would subscribe for a shilling; indeed, I do not suppose the Board of Works expected. I think that the demand for a fixed rent is made purposely to defeat me.

1941. You demand a preference dividend, do you not, for your shareholders of 20 per cent.?—No; that is a statement put forward by another member of the Board. Certain resolutions have been passed by different city wards and vestries in favour of my getting this concession, and, amongst others, the Portsoken ward passed a resolution in support of my plan. That was sent, by order of the ward, to all the vestries in the Metropolis; amongst others, it was sent to St. George-the-Martyr, Southwark, and in the "South London Journal" of Saturday, April 2d, 1864, there is a report of that having been read before the vestry. It is as follows: "A letter was read from the Portsoken ward, City, enclosing a copy of resolutions passed at a meeting of inhabitants of that ward, favourable to the scheme of Mr. Ellis for utilising the Metropolitan sewage. Mr. Collinson did not think the scheme of Mr. Ellis very favourable to the ratepayers, inasmuch as he proposes, first, to pay the company; he proposes forming 20 per cent. from the profits, and then divide the remainder of the profits between the Metropolitan Board and himself. Another was, that the Metropolitan Board had no powers by which they could become partners in a trading concern. The letter was then referred to the committee, who had this subject under consideration."

1942. Then you do not propose to have this preference dividend?—It is entirely untrue from beginning to end. I called the attention of the Chairman of Board of Works to it, and I did not even receive a reply.

1943. Would you bring a Bill into Parliament?—Yes, certainly. I am prepared to lodge a sum of 60,000 *l.* for preliminary expenses; and I am desirous to be tied up, so as not to be able to raise the capital till I can prove that all that I have said, in reference to the sewage, is true.

1944. Have you the 60,000 *l.*?—Yes, as you will see from my tender, in a letter from Messrs. Payne, Eddison, & Ford, the first solicitors in Yorkshire. Not only are we too ready to fight it out at our own expense, but we are very anxious to be tied up, so as not to be able to raise a sixpence of our capital until we have got an Act; and that is the reason why we have been abused by the artificial manure trade as getting up bubble companies and hoodwinking the public.

1945. Mr. *Tite.*] You spoke of an acceptance by the Metropolitan Board of Works of some proposition by Messrs. Napier's company, and you seem to have an impression that an injustice was done you, in their not returning you an answer, the Board of Works having apparently accepted their tender, in some sense, before you made the application to which you have referred; is that so?—No; I think the honourable Member misunderstood me. What, I think, I stated was, that the date of the letter which I received from the Metropolitan Board of Works, calling on me to expend 134,400 *l.*, and to devote some years to those labours, is the 16th of November 1861; and, it appears from the engineer's report, that four days previously to the writing of that letter, he had received instructions from the Main Drainage Committee to report upon one scheme, and upon it alone, that not being mine; I consider that to be a very great act of injustice, because it is trifling with me to ask me to devote several years of labour and a great deal of money to obtain information which the Board evidently did not want.

1946. But you infer that rather; do you imagine that they were aware that it would cost you 130,000 *l.* to give you the information that they asked you for?—They were bound to know it; they have an engineer, and, I presume, that the engineer was consulted as to what would be the cost of getting that information.

1947. What is the date of the letter?—The 16th of November 1861.

1948. Who is it from?—From John Pollard, Clerk of the Board: "Dear sir,—I am directed to inform you that your communication with reference to the sewage of the metropolis, together with others of a similar nature, having been under the consideration of the committee to whom the subject has been referred, they have arrived at the conclusion that, before coming to a final decision with respect to any of them, it would be necessary that they should have every possible opportunity for testing the efficiency of the scheme in an engineering and chemical point of view, and for satisfying themselves that the requirements of the Act of Parliament, relating to the subject, shall in no way be infringed by the creation of nuisance in carrying out the works. With this view, I am to request that you will be good enough to supply a map and sections, showing the area of intended operations, the levels of its surface, and the lines, levels, and sizes of the intended aqueducts, indicating the various kinds of surface soil with which it is proposed to deal, and showing, in detail, what mode of subsoil drainage it is intended to adopt, if any, with the size, depth, and inclination of the several proposed lines of drainage, together with descriptions and particulars of the pumping power to be employed, the number of lifts, and the nature of the outfall. Also, a statement showing the manner in which it is proposed to work the scheme, what kind of powers will be taken for dealing with the land to be operated upon, and how owners and occupiers are to be treated with; what quantity of sewage will be taken up daily, over what quantity of land it will be distributed, what depth it will occupy over that area of land, and, if it be intended to employ varying quantities at different seasons, what the variation will be. Also, a full statement of the means of deodorisation, if any, the chemical agents employed, and the details of their mode of application, and what arrangements, if any, it is proposed to make for dealing with the heavy deposit. Also an estimate, showing, separately, the cost of the engines and pumps, if any, the conducting pipe or sewer, the distributing and deodorising apparatus, and the subsoil drainage; together with the annual working expenses of each of these three heads of expenditure. I am, &c., *John Pollard,* Clerk of the Board." Now, at the time that the Board of Works wrote me that letter they had before them, nearly a year previously, all the estimates which the noble Chairman has referred to in my examination, which are found at length in their report.

1949. Then you imagined that they wanted something very much beyond what you have stated to the Committee to-day?—Clearly.

1950. Might you not be mistaken in that

matter?—I could not be mistaken; it does not admit of a mistake.

1951. You were asked to give a detailed estimate of the character of the soils; most of that might be given from a geological map without a great deal of trouble, might it not?—Some of it could not be given.

1952. With regard to the suggestion that you made, that the Board of Works had applied, or rather that they had desired, to come under some engagement with Mr. Napier's Company four days before this requisition was given, what do you understand was the nature of that; was it not simply referred to Mr. Bazalgette to report upon it?—To report upon it, and upon it alone.

1953. Then, is it not perfectly possible that that scheme might be in a condition for them to report upon, and that the Board considered that yours was not?—They had received at that time a great deal more information from me than they have got from all the rest up to the present day.

1954. But might not one have been in a condition to be reported upon and the other not?—But mine was in a condition to be reported upon, and the other was not in a condition to be reported upon.

1955. That is a matter of opinion. With regard to the scheme of Messrs. Napier and Hope soon after that it was given up altogether, was it not?—No; the next step was for the Main Drainage Committee to report in its favour. Following the report of Mr. Bazalgette the Main Drainage Committee reported in the strongest manner possible in its favour. They state here, at page 9 of their report, "Your Committee being fully impressed with the great importance of the subject entrusted to their consideration, have devoted considerable time and careful attention thereto, and have arrived at the conclusion that it is desirable your Honourable Board should entertain favourably the proposition for dealing with the sewage of the northern area of the metropolis contained in the communications from the Honourable William Napier and Mr. Hope."

1956. What is the date of that report?—The 1st of January 1862.

1957. And what is the date of the letter?—The 16th of November.

1958. Of the year before?—Yes.

1959. Then all that came to nothing, did it not?—It came to nothing, because Parliament appointed a Committee before the concession could be granted.

1960. Did it not come to nothing because they had no means of depositing for the Bill?—That was another reason, they were running all through London trying to get the money, and they could not get the money, and did not get the money.

1961. Subsequently to that, in February this year, were you not invited again to attend before the Main Drainage Committee of the Board of Works?—Yes.

1962. And you were then asked a great many explanations, such as have been given to-day?—Yes, and I protested against their being printed.

1963. Do you protest still?—Yes. I have my protest in the "Star" newspaper of to-day. I have seen a copy of what professes to be a correct report of that examination, and it is a falsification of my evidence from beginning to end. There never was a more gross attempt to assassinate a man's character; it is intended to ruin my character with the vestries. I sent a copy of my protest to the Chairman of the Metropolitan Board of Works, and I should be glad to put it on the minutes of this Committee.

1964. Was there a shorthand writer present?—I do not know.

1965. Then you mean to say that the report of what you stated at that meeting in February is not correctly reported by the Board of Works?—They sent me a proof of it, and not a single question or answer was correctly rendered.

1966. Are you aware that a shorthand writer was present?—I do not know.

1967. Do you imagine that the report could be falsified by the officers of the Board?—Deliberately.

1968. Be that as it may, you objected to the explanations which you gave being printed?—Decidedly.

1969. You do not object to a correct report being printed, do you?—Not a correct report; but that which was sent to me was not a correct report.

1970. How was it sent to you?—It was sent under cover from the Board, in a letter. I unfortunately have not got the document with me.

1971. What is the date of it?—The date of the letter is the 24th of May.

1972. And what does the letter that you received from the Board state?—That the Main Drainage Committee had resolved to print the questions put to me, and my replies, and had sent me a proof for correction, and that it was merely for the use of the Main Drainage Committee.

1973. What was your answer?—My answer was to point out in detail some of the falsifications of my evidence.

1974. Mr. *Adderley*]. Do you mean that as a charge against the Board of Works?—I mean it not as a charge against the Board, but as against certain parties at that Board.

1975. Mr. *Tite*]. You do not agree with the correctness of that statement?—Certainly not.

1976. You have used the word "falsification," have you not?—Yes.

1977. Men may make mistakes. Do you withdraw that word or do you abide by it?—We will put it down charitably as a mistake.

1978. But there is no need of any charitable construction?—The report is incorrect.

1979. However, you did attend on a certain day in February, did you not?—I did.

1980. The Chairman of the Board, Mr. Thwaites was in the chair, and certain questions were asked you?—Yes.

1981. And you object to the questions and answers being printed in the form in which they reached you?—My reason for objecting, on the first occasion, was simply this; that I believe the reason of my being called up before the Board was solely to enable certain gentlemen, who were considered to be favourably regarded by the Board, to send in re-tenders to the Board, I having in pamphlets, which have been distributed by the thousand over London, exposed the errors of their plans.

1982. All the tenders were examined, were they not?—I do not know. I was examined, and I believe other parties also.

1983. Were not all those examined who were then remaining as tenderers?—I cannot say, of my own knowledge.

1984. At the meeting to which I refer, I think I was not present?—You were not present.

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1985. You do not know, in fact, that Mr. Shepherd was examined, and that Sir Charles Fox was examined?—I heard that Sir Charles Fox, Lord Torrington, and Thornton Hunt, the editor of the "Daily Telegraph," were up for two days. I do not know whether that is correct or not.

1986. Was Dr. Thudichum examined?—I do not know.

1987. You do not know that all parties tendering were asked to come before the Main Drainage Committee, and that you were one of them?—I should say that that was very probable, because on my own supposition, that would be the course taken.

1988. If phosphates were introduced into this sewage water, would the phosphates fall, or would they be kept in suspension, and float along with the water, or would they be deposited?—I do not enter into the chemical portion of the question. I deal with the sewage as I find it. Messrs. Hofmann and Witt say that the sewage is worth 2 *d.* a ton. Baron Liebig says that it might be very much increased in value if anything of that sort were done; but that would come under the province of the chemist of the company.

1989. If the phosphates were not held in suspension of course it would not be of very great value?—No, unless they were dissolved.

1990. With regard to quantity, is there not among agriculturists a system of high farming and the contrary?—Yes.

1991. And does not that consist, as in Mr. Mechi's case, in putting on very poor land a very large quantity of very rich manure?—You can put a large quantity of solid manure, but not of liquid manure; because the liquid manure will run away.

1992. Then your remark applies that there is a limit to liquid manure, but not to solid, is that so?—If you put a larger quantity of liquid manure on the earth than the earth can deal with it runs to loss. Professor Way's evidence proves that.

1993. Have you been acquainted at all in the course of your life with the raising of large sums of money for speculative purposes like this?—No; I am not a getter-up of companies. As a professional man, of course, things of this sort have come under my notice.

1994. Then you are not acquainted with the possibility of raising a large sum of money on a conjectural question of this kind?—I do not consider this a conjectural question, because the evidence taken proves the value of the sewage.

1995. But after all, it would turn upon the farmers choosing to take it, would it not?—I can produce, if necessary, evidence to show that whenever farmers have the opportunity, they always take it; but, of course, it will be necessary for me to produce a very large quantity of that evidence when bringing the matter before Parliament.

1996. Do you think it reasonable to expect that a capital of nearly 6,000,000 *l.* could be obtained from the public to carry out this very large scheme if the Board of Works gave you in perpetuity a concession of the sewage water?—I only ask for a conditional arrangement, and not in the first instance a concession of the sewage. What I ask for is an arrangement, to be turned into a concession of the sewage when we get our Act, and establish our Company, and raise our capital, and not until then. If we fail in performing all the conditions of our arrangement, we do not get the concession. As to the amount of capital, that estimate, as I have already explained to the Committee, is very greatly in excess. I have had it checked by Mr. Samuel Hughes, and running his prices out to an extreme point he only makes his estimate somewhere about 4,000,000 *l.* for the works, I believe that the works in reality will not come to much more than 3,500,000 *l.*

1997. Then you propose at all events that the Board of Works should be bound for a certain time to abide by the event of your getting up the company and getting up the capital, and getting the Act of Parliament. Is that your proposition?—It would amount to that, that a certain time should be allowed to us as to any other person, in which we will perform all the conditions of our contract.

1998. How long a time do you propose?—If the concession were granted to me now, it might be within the reach of possibility for me to make the surveys in time for next session. I have to take the levels, and to survey 1,680 square miles; that is an enormous matter, and that must be done before I can make anything like an accurate estimate of the cost. Unless the concession is granted to me in time to enable me to make those calculations before next Session, of course it would not be possible for me to come before Parliament next Session, but I will endeavour to do so.

1999. Would two years be a proper limit?—It would be ample.

2000. As to the desire of farmers to take this kind of sewage manure, what is the extent of your acquaintance with their willingness to do that generally?—I have not made it my business to go and ask the farmers if they would take sewage if it was brought to them, because that would not be a sensible course to take; but the evidence before the country proves, that wherever people have had the chance of doing it they have always done so.

2001. Have they paid for it?—No, because up to the present time sewage has always been regarded as a nuisance, and as a thing to be got rid of. I believe that I have been the first person almost who has put the matter in a definite way before the country. Of course I should have to produce evidence before Parliament on all those points.

2002. Mr. *Adderley.*] Have you any personal experience of any experiments on sewage?—No. I have never made any experiments with sewage, because I have never had the opportunity of getting town sewage; but being educated as a agriculturist it was my business to make myself acquainted with what could be done with all descriptions of manure, and in all ways, and therefore the knowledge that I then acquired was quite sufficient for myself upon this matter.

2003. You based your calculations upon experiments in various parts of the country, but you have not yourself been engaged in any one of those experiments?—No.

2004. Do you arrive at your opinion from the various reports which have reached you of the experiments in different parts of the country?—I arrived at my opinion by a comparison between the very bad results obtained in a commercial point of view, when very much sewage has been applied, and the very good results which have been obtained when it has been applied in small quantities, and therefore I say that it is wrong to use it in large quantities.

2005. Have you made yourself master of all the

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the circumstances in those different localities, both as to the soil and as to everything else?—No, I have not, because I consider that the evidence proves that the sewage is a manure suitable for every description of soil, but that its best results, as in the case of every other manure, will be obtained on the best soils.

2006. You have stated in your evidence, have you not, what you consider to be the value of the solid deposit of town manure, as compared with the overflow?—No; I have not gone at all into the question of the solid deposits. I do not approve of any plan for precipitating the manure.

2007. Are the statements which you have been making to the Committee, as to the value per ton, and as to the amount of dressing per acre, with reference to the whole body of sewage as it comes from the town, or with reference to the overflow after a deposit has taken place?—My estimate is based on the value of the sewage as it flows from the outfall of the sewer, without reference to any deposit.

2008. Then, did you propose, in making reservoirs at Shooter's Hill, and other places, to pump up the whole mass of the sewage without any deposit?—The sewage will be pumped by the Board of Works. On either side of the river they will lift it, I believe, forty feet.

2009. When you say that the pumps will lift the sewage, do you mean that they will lift the whole mass of sewage, without any deposit by gravitation?—No; I presume that, for the safety of their own pumps, they must clear it of all foreign matters, such as sticks and stones, and so on; and therefore it will come to the outfall-tanks free from that matter; and then, again, it will be purified by my gratings.

2010. In your last answer, I understood you to state that you contemplated a certain amount of deposit before the sewage goes into your outfall. Is that so?—There is, of course, in the sewage a large amount of foreign matter; but that, I presume, must be taken out by the Board of Works before it passes through their pumps; and therefore, when it comes to the outfall-tanks, it will be freer from that matter than the specimen of the sewage which is contained in this bottle which is before me.

2011. But would not there be a very considerable mass of matter which would be so screened?—The Board of Works would have to deal with the larger mass of it; what I should have to deal with would be comparatively very small.

2012. Mr. *Ferrand.*] Did I rightly understand you to state that you proposed to deliver the whole of the sewage under ground?—The pipes will be laid under ground, at a depth below the reach of frost.

2013. And will the sewage be delivered upon each farm through a meter?—It will pass through a meter.

2014. Do you propose to deliver the sewage at the same price to all distances?—Yes, on the principle of the penny postage.

2015. But will not the sewage which is delivered to the nearest place on your works to London be richer and better than that which is delivered at a distance?—I do not think that it will.

2016. That would be the case in great thunder storms, would it not?—No, I don't see that it would. The sewage will be richer in thunder storms than at any other time; that is proved by Messrs. Hofmann and Witt's analysis.

2017. But would there not be a greater amount of sediment in the first few miles?—No; it was my object to prevent any sediment from getting into my mains by screening it.

2018. What width would the screen be?—There would be a considerable number of very fine gratings in the canals.

2019. Do you propose that the farmers should apply the sewage to their lands in surface drains, or under ground?—That would entirely rest with them; they might apply it in a variety of ways.

2020. Supposing that they were to apply it on the surface, do you believe that it would be any nuisance to the people living in the immediate neighbourhood of those fields?—The evidence which Lord Essex gave before the Select Committee in 1862 proves that his Lordship has received no annoyance from applying it to a large portion of his demesne, and he has been applying it for many years.

2021. Have you heard of any annoyance being created by sewage when applied on the surface of the land?—I have heard of none. When it is applied in such large quantities as at Edinburgh, I believe there is some annoyance, but they are taking measures to remedy that.

2022. Mr. *Adderley.*] Does Lord Essex deodorize the sewage?—Not at all.

2023. Mr. *Ferrand.*] What would be the depth below the ground of the drain that you would propose to take the sewage in?—About 2½ feet, I think, would be sufficient.

2024. The honourable member for Bath asked you whether you would be satisfied with two years. How long do you expect it will be before you could distribute the whole of the sewage, after you have got your Act?—I understood the question of the honourable member for Bath to refer to the time within which I could get my Act, and raise the capital. The laying of the works could not be done in two years; it would take at least three years to carry out such large works.

2025. Do you mean after you got your Act?—Yes, after we got the Act.

2026. Would it take five years from this time before you would be able to take the sewage?—No. I would apply for an Act next Session, if possible. But it is not my fault if we are to be delayed five years more to utilise the sewage, because for three years I have been trying to make some arrangement with the Board of Works.

2027. Supposing you got your Act next year, how long would it be after that before you would be able to distribute the whole of the sewage?—Something under three years.

2028. How much would you be able to distribute the first year?—Our object would be to lay down the works on one side complete at once.

2029. You cannot make any statement to the Committee as to what progress you would make in the first year, or the second year, but you only state that in three years you would complete the works?—It would be impossible to say precisely; very much would depend on the time that would be taken in the casting of the pipes, and that would be beyond my province.

2030. You were asked as to the sewage in frosty weather, and you stated that you purposed to convey it in pipes under-ground, beyond the reach of frost, and that the farmer will take it then on to the land through the meter, but what is there to prevent the farmer from laying it on the

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the surface in frosty weather?—There would be nothing to prevent it, if they chose to do it; but as the earth would not absorb it, they would lay it on the land at a loss to themselves.

2031. Then is it your opinion that the frost would destroy the strength of the sewage?—No; but that the earth would not absorb it.

2032. But if I tell you that I apply sewage to land in frosty weather, and that I have seen it a foot in thickness in ice, and that when the thaw came it melted gradually on to the land, and became absorbed, would it alter your opinion?—That would be the case, no doubt, ; but during the continuance of the frost it could not be absorbed. There would be nothing to prevent the farmers from applying it at all times, but I assume that they would not do so.

2033. Of course, there would be no annoyance from the sewage being in a frozen state?—Of course not.

2034. You stated that Messrs. Payne, Eddison, and Ford, were the leading solicitors of the West Riding; would it not be perhaps nearer the mark to say that they are among the leading solicitors?—I have always had a very high character of them.

2035. You have stated that Messrs. Payne, Eddison, and Ford, promised to advance you 60,000 *l.*; is that so?—No; their clients will advance it.

2036. Are you aware who those clients are?—Yes.

2037. Are those clients able to advance you a further sum of money beyond the 60,000 *l.*?—Certainly; they would not risk the 60,000 *l.*, unless they could afford to lose it.

2038. Mr. *Hibbert.*] You state that you propose mixing other manures with the sewage; is that because the sewage is deficient in manurial constituents?—That was an idea of Baron Liebig's; he said some time ago that the sewage of London might be increased in value by having superphosphate of lime added to it.

2039. What average per acre of land do you propose to apply?—My area is arranged on an average of 500 tons to the acre.

2040. At what price do you suppose you could deliver it?—That would depend upon the rate at which we could pump the sewage.

2041. Have you made any calculation of the height?—Yes; if we had to lift the sewage on the north side to 460 feet, that would cost us ·267,121 *d.* or ¼ *d.* ·017,121 for each ton, or a little over a farthing a ton.

2042. Does that include the cost of the sewage as well as the cost of the carriage?—That would be the cost of pumping only, and lifting it to a height of 460 feet, and that, I believe, is excessive.

2043. Have you made any calculation at all as to the price per ton at which you could deliver the manure, including both the cost of the sewage itself, and of the carriage, and, in fact, all the expenses?—There would only have to be added to that the expense of management.

2044. Would you be able to supply it to the farmers at 1 *d.* a ton?—Yes; we could sell it at 1 *d.* a ton. According to Mr. Hughes's estimate, assuming that we had to lift the sewage 200 feet, there would be a dividend of £. 15·1 per cent. on the capital of £. 4,445,320. If we had to lift 300 feet, there would be a dividend of £. 12·9 per cent. If we had to lift it 400 feet, there would be a dividend of £. 11 per cent. If we had to lift it 500 feet, there would be a dividend of £. 9·3 per cent., selling it at 1 *d.* a ton.

2045. It would depend very much, would it not, upon the height to which you lift it?—Yes.

2046. Have you made any calculation as to the amount of sewage that the farmers are likely to take; will they take 500 tons per acre per annum?—I think that is too large a quantity to expect them to take at all times, and therefore the area will, perhaps, have to be a little more extended. If I sell it at 1 *d.* a ton, I daresay they would take 500 tons an acre; but I am speaking of selling it at 2 *d.* a ton; it is a matter of price.

2047. Do you think that, on any system which proposes to use 500 tons of sewage per acre per annum, the farmers would be willing to pay for that amount?—Perhaps not.

2048. You have stated that Professor Way said that there was a chemical attraction possessed by the ingredients of a fertile soil, which separated from any liquid containing manure all the important elements of manure which that liquid contained—would that attraction operate in the case of soil which is composed chiefly of sand?—No; there would be less power in sand of extracting the manurial properties from the sewage, but of course you could pass a greater quantity through sand in a limited time: in fact, you can lose more manure of any sort on a sandy soil.

2049. In point of fact, would it not take the manurial value from the sewage?—No, it would absorb it.

2050. Would not much of the manurial matter go into the drains?—It would after a certain point.

2051. You have stated that the Rugby experiments have been unsuccessful; is that, in your opinion, from the large amount of sewage which they use per acre?—I consider them to be unsuccessful, but Mr. Lawes considers them a great success. The evidence of Professor Way proves that there is a limit to the power of the earth to receive manure, and that that limit is very soon reached; therefore, when you put sewage in the great quantity that Mr. Lawes does upon the earth, you must run it away to loss, because the earth cannot deal with it.

2052. What amount of sewage per acre per annum did he apply?—On one part of the land 3,000 tons, on another part 6,000 tons, and on another part 9,000 tons per acre.

2053. Do you know what amount Mr. Mechi applies to land with advantage?—I think it is very small; it is 45 tons or something of that kind. I have a letter from Mr. Mechi about that which gives some rather curious information. His is farm sewage, and it is supposed that that is much richer than the London sewage, but I find from this letter, which is dated the 27th of May, that the sewage which he applies is about one-third of the strength of the London sewage; it has been analysed by Professor Voelcker.

2054. You stated that you had a covered aqueduct from the outfall tanks to your works; what is the distance from your works to the outfall tanks?—They are quite close.

2055. You state that the Board of Works lift the sewage 40 feet; where do they lift it?—I am not aware of the exact point; I think it is at Abbey Mills, but I am not quite certain.

2056. Is that before they reach the outfall?—It is before they reach the outfall.

2057. With regard to the mains which you propose to take, three of which are on the north side, and two on the south side, do the three on the north side run parallel to each other, and close together?—They are quite close together.

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2058. Is any provision made for stopping the flow of the sewage in case of accident?—Yes; the usual arrangements are made, as in all waterworks, so as to be able to shut it off from any of the mains.

2059. In case of accidents what provision is made?—We should have to drive the sewage a little faster through the other two mains until we had mended the third.

2060. Do you propose having your reservoirs within the metropolitan district?—That will depend upon the levels. I cannot state what the levels will be until I have ascertained the precise area; but I have promised to the Board of Works that they shall not be placed in any spot of which they will disapprove.

2061. You are aware that they object to those reservoirs?—Yes.

2062. Have you made any arrangement for cleaning your reservoirs of any residuum that may be in them?—As in all waterworks they will be divided into compartments in the usual manner, so that you can shut off the flow.

2063. Are they level at the bottom, or are they lower at one end than at the other?—I dare say there would be a little slant to facilitate the cleaning out of the bottom; but those are details that will be worked out by the engineer of the Company.

2064. Supposing that you fail in disposing of the sewage, how would you get rid of it?—It remains in the mains until it is taken, or we could arrange to blow it out at different points if necessary.

2065. Would not that create a nuisance?—No; the farmers would be very glad to get it for nothing; but I think there would be no necessity to do that.

2066. You state that you have not consulted with any farmers as to their taking the sewage; have you any doubt as to your being able to persuade them to take it?—Not the slightest; every farmer knows that there is great value in the manure, and the evidence proves that sewage is the best manure. If you can put it on the land, at a reasonable rate, they will take it.

2067. The Board of Works required you to provide a map and certain sections, which you state you decline to deliver to them. Are you aware whether the Board of Works required similar information from Messrs. Napier and Hope?—I should think that it was very probable that they did send the same circular to every other person who tendered, but I was the only person who had a definite plan before them at the time, in addition to Messrs. Napier and Hope.

2068. Are you aware that Messrs. Napier and Hope propose to apply the sewage on each side of their long aqueduct?—That was not their original proposal; that was in an after proposal of theirs.

2069. Do you know whether they delivered in any maps and sections of the land to which they intended to apply the sewage?—I inspected, in the Private Bill office, the plans that they furnished, which were merely a line drawn out into the sea, and showing the area which they proposed to inclose from the ocean.

2070. Do you not know whether or not they provided a map and sections at all similar to yours?—If they did, it was quite a different affair from mine, because the cost of theirs would have been much smaller, on account of the smaller area with which they proposed to deal.

2071. Do you know, or do you not know, whether they provided maps and sections?—I do not know.

2072. Mr. *Ferrand.*] You stated that Messrs. Payne, Eddison and Ford, had offered to supply you with an amount of 60,000 *l.* Are Messrs. Payne, Eddison and Ford to be the solicitors of the Company, if one is formed?—No.

2073. Have you any idea who are to be the solicitors of the Company?—No.

2074. Is not that arranged yet?—No.

2075. Have Messrs. Payne, Eddison and Ford told you what further sum of money they are prepared to find?—They are not the parties; it is their clients who will find the money. I may state that that 60,000 *l.* is merely for the preliminary expenses, and bringing the matter before Parliament.

2076. Is it not for the deposit?—No, it is not for the deposit, it is merely for the preliminary expenses, in making the surveys, and so on.

2077. What further sum have Messrs. Payne, Eddison. and Ford stated that they are prepared to find for you through their clients?—None at all; I have not asked for any further amount, because I did not consider it necessary.

2078. Did you not state that you had no doubt that they would advance a further sum?—I do not think I said that.

2079. Did you not state that you would get 60,000 *l.*, and that when the company was formed and the Act obtained, Messrs. Payne, Eddison, and Ford would obtain a further sum of money?—If I said so, I did not understand the question which was put to me, because I have never asked them.

2080. Sir *Frederic Smith.*] Should you not require to have the whole of your capital paid up at once, so as to allow no very great intervals of time to elapse between the instalments?—No, it would not be necessary to pay it all up at once.

2081. But would it not be called in as fast as the works were completed?—Yes.

2082. So that when the works were completed the whole of the capital would be paid up, would it not?—The whole of the capital would be paid up.

2083. Should you have to pay the owners of land for passing the pipes through their lands?—No, because I should lay the pipes along the roads; every farm must have a right of way to a road.

2084. You gave a very large figure as to the probable cost of making the surveys and sections, and taking the levels required by the Board of Works. Was that large amount founded on any accurate estimate?—I consulted some engineers on the question.

2085. Was that a real consultation?—Yes; it was their opinion that it would cost 2 *s.* 6 *d.* an acre to get that information.

2086. That seemed to me, as an engineer, to be an enormous sum, taking the whole amount that you gave for geological surveys, and things of that kind?—Even if it were 1 *s.* an acre, that would be a very large sum, particularly when it was not wanted at all.

2087. You state that you have not made any inquiries of the farmers in your neighbourhood as to taking the sewage; that was, perhaps, cautious on your part; but have you made no inquiry elsewhere beyond the metropolitan district?—No; I have not made any inquiry on that point.

2088. Do you take it for granted that any man would use manure who could get it at a cheaper rate than you would offer it at?—I think not.

2089. Would

Mr. *T. Ellis* and Mr. *J. Boring.*

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2089. Would you be astonished to hear that a large proprietor has erected works, at very great cost, to be used in a certain district, and that all that he required was, that the occupiers of the ground should pay for the pumping, and that, after two or three years' experience, they declined to pay for the pumping?—I should be astonished, if no explanation were offered.

2090. Those works were erected by the Duke of Northumberland, and then the inhabitants and occupiers of the land in the district refused to pay for the pumping. How do you account for that?—I do not know what the strength of the sewage was, and whether it was good or not; and I do not know whether the sewage might not have been poisoned before it reached the land. I could poison any sewage. The Duke of Northumberland holds a very high position as an agriculturist, and if he threw the weight of his name and influence into this question, it would be solved at once, and it would therefore pay the artificial manure men to poison the sewage.

2091. The result was that the thing was given up greatly to his Grace's disappointment?—We could introduce into the sewers of any town matters that would render the sewage actually injurious to the land.

2092. Might not that happen in the case of the Metropolitan sewage?—No; that is too large in quantity; it defies it.

2093. With regard to the extent of your reservoirs, are they of sufficient capacity to meet the requirements of very wet weather, when, of course, you would have a greater accumulation of sewage and less need for it on the land?—I do not know what quantity of sewage will be delivered, but I do not believe that the main sewers, as constructed, will carry all the sewage that is generated.

2094. Do you think that they are too small?—I have heard it stated that they are. I have not examined into the question myself, but I find a statement to that effect in this letter from Mr. Hughes, who is an engineer.

2095. Supposing that they should be ample, are your reservoirs sufficiently capacious to take all the sewage?—No; they are not sufficient to contain all the sewage that is generated; but basing my calculations upon Mr. Bazelgette's figures, my reservoirs will hold as much, and more sewage than the Board of Works reservoirs will.

2096. Therefore you follow them, if theirs be sufficient?—Yes.

2097. But is not the difference this, that they want to get rid of their sewage, and you want to retain yours?—I want to retain all that I can dispose of.

2098. And you want to repay the public?—Yes.

2099. Would you reckon the cost of the pumping at about ¾ *d.* a ton?—No; assuming that I have to pump it 460 feet, it will cost me a little more than ½ *d.* a ton.

2100. Sir *Joseph Paxton.*] You have two large reservoirs, have you not, one on Shooter's Hill, and the other at Hampstead?—One on either side of the river, but they will not eventually be placed at those points.

2101. But you must have them in very high situations, must you not?—Yes.

2102. Taking the north side, for instance, must you not go to Harrow before you find another place?—I think that you can get a sufficient elevation in Epping Forest, and so Mr. Hughes thinks.

2103. Do you think, for instance, that after the accident that occurred in Sheffield, any reservoir will be allowed to be put up anywhere near London, on Shooter's Hill, or at Hampstead Heath?—Yes; because the reservoir near Sheffield was formed by constructing a dam across the valley, whereas my reservoirs will be constructed in a hole which I should excavate in the hill.

2104. But do you imagine that the London ratepayers would like to have the sewage that they want to get rid of pumped up to a hill with the chance of its coming down through their streets?—It will not come through the streets; and, if I may judge of their feelings by the resolutions which they have passed in my favour, I should think that they would be very glad to dispose of the sewage in that way.

2105. Their resolutions in your favour are caused very much, are they not, by the price which you offer to give for the sewage?—That may be so.

2106. Have you any parties who would come forward and guarantee a certain amount of money for the sewage?—I should not think of proposing that, because it must necessarily be a fraud upon the ratepayers. It would be impossible for me to guarantee the ratepayers such a sum as the sewage is worth.

2107. But could you not guarantee a minimum amount?—That would only have the effect of throwing an impediment in my way, and defrauding the ratepayers.

2108. What do you suppose that the ratepayers would get?—They would get half of whatever I made, and I believe that I shall make at least 2 *d.* a ton in a few years; out of that would be deducted the working expenses.

2109. Have you gone into any calculations as to the distribution of the sewage over this enormous area which you mention with regard to the engineering part of the question?—Yes; you will find it referred to in the pamphlet which is published by the Board of Works.

2110. But have you had the advice of some really eminent engineer, who is acquainted with the pumping of water, and has had great experience in it, who could give you that information which would be desirable for such very large works as these?—About the cost of pumping, there can be no question at all. The price that I have given can be easily checked; and upon the evidence of engineers, and a variety of parties whom I consulted at the time, I gave that price.

2111. But did you take any sections through the country over which you propose to take the sewage and pipes?—From the summit-reservoir.

2112. How far do you extend your area?—About 23 or 24 miles round London.

2113. What will be the size of the pipes?—They will vary according to the area: as we travel from London they will get smaller.

2114. On what principle will they get smaller?—Because those pipes near to the reservoir will have to supply the area through which they travel, and also to convey sufficient sewage for the further areas.

2115. Would the extension be so great as to counterbalance that; would not it be necessary to increase the size of the pipes?—No.

2116. Have you that from any engineer?—Yes, the amount of friction would be overcome by the head of sewage.

2117. Did you ever hear of a scheme for bringing gas from Derbyshire to London, which was projected

Mr. T. Ellis and Mr. *J. Bowing.*

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projected many years ago, and entertained by George Stephenson, the great engineer. That scheme was thoroughly investigated, and they proposed to put very large pipes to convey the gas, but it was found that the gas would all be lost before it reached London on account of the amount of friction?—The distance in that case is much longer than mine.

2118. This is a question upon which I have had some experience. Have you consulted engineers as to the amount of friction that would be necessary, and the size of the pipes that would be necessary to carry the sewage for 20 miles round London?—Yes; those are all given in the calculations appended to my tender, and those figures can of course be tested.

2119. Whom have you consulted as an engineer?—I have no engineer at present.

2120. Then how did you manage to get up all this information?—I worked it up myself, with the assistance of Mr. Bowing. I consulted several engineers, and among others Mr. Hughes, whose estimates for the works I have here. They have been sent in to the Board of Works, and have probably been furnished to this Committee by the Board of Works. But I may mention that these questions which the honourable Member has asked me, will all have, of course, to be fully investigated before a Committee of the House of Commons, when I am applying to Parliament for my Bill. I am not now applying for a Bill, otherwise I would not stand here alone as I do. I am merely asking permission to test this matter before Parliament at my own risk, and I do not wish to take any steps in raising capital until I have proved all that I have asserted; in fact, I wish my hands to be tied, so that I cannot raise sixpence from the public, until after I have taken the matter before Parliament.

2121. And until you have deposited the 200,000 *l.*?—Yes; I would be quite ready to do so.

2122. The ratepayers appear to have a great affection for you. Why do you think it would be an insult to them to offer them an annual sum for the sewage?—I said that I thought it would be a fraud upon them.

2123. But it would not be a fraud if you gave them an annual per-centage; could you not offer them 100,000 *l.* for the sewage?—That would not be a fair rental.

2124. Or could you not offer them a rental increasing from 100,000 *l.* to 500,000 *l.* a year?—I think that that would be a bad arrangement for them; it would be throwing an impediment in the way of my raising capital, and it would be unjust to them.

2125. How could it be unjust to them?—Because the sewage of the metropolis is the property of the ratepayers, and they have a right to get for their property the utmost possible value. I propose an arrangement which, I think, will give a fair and just amount to them; any other arrangement would be unfair to them, and would throw an impediment in the way of raising the capital.

2126. How do you propose to raise this capital?—In the usual way, by the medium of a Company, through shares.

2127. Should you have a board of directors and a prospectus, and an engineer's report?—Yes. The way in which I propose to raise the capital will be based on the results of the inquiry before Parliament when I am applying for my Act.

2128. Then do you ask for a concession of this sewage in order to enable you to go to Parliament to get an Act, and then to get up a company afterwards to deal with the sewage?—I ask for a conditional arrangement, which is to be turned into a concession in the event of my getting the Act, and I state in my proposition to the Board of Works, that after having got my Act I am not to advertise for my capital until they have approved of my board of direction, and until half a million of the capital is subscribed for by my private supporters.

2129. According to your account, you will want nearly a whole county to irrigate, will you not?—That is caused by the vast amount of the sewage.

2130. Do you believe that you could irrigate half a county?—So much the better if we could, because we could raise the more food.

2131. Did I rightly understand you to state that the better the land was, the better it would take the sewage?—The better the results would be; but the worse the land was, that is, the more sand there was in it, the more sewage you could get rid of. I wish to turn the sewage to a profitable use.

2132. Are you an agriculturist?—I was specially educated to take the management of land.

2133. Have you ever had the management of land?—I assisted my father for 10 years in the management of very large estates in Ireland.

2134. In what part of Ireland were those estates?—In different parts, in the north and south. My father is agent, for instance, to Lord Portsmouth, in Wexford, for property to the amount of 10,000 *l.* a year; and, in the north of Ireland, to Sir Thomas Lennard, for property also to the amount of 10,000 *l.* a year; and in different parts of the country.

2135. Have you ever had the charge of land, solely, yourself?—I have never had it myself, personally, but I have superintended it for my father.

2136. Have you ever acted as agent for any property?—I merely acted with and for my father.

2137. Have you ever had any farm to try experiments upon?—No; I have merely tried experiments on my father's land.

Jovis, 2° die Junii, 1864.

MEMBERS PRESENT:

Mr. Caird.	Lord Robert Montagu.
Mr. Cowper.	Mr. North.
Mr. Ferrand.	Sir Joseph Paxton.
Lord Fermoy.	Sir William Russell.
Mr. Hibbert.	Mr. Tite.
Mr. Leader.	

LORD ROBERT MONTAGU, IN THE CHAIR.

Mr. WILLIAM WEST, called in; and Examined.

Mr. *W. West.*

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2138. *Chairman.*] YOU represent the eminent firm of West & Sons, of the St. Blazey Foundry, at Par, do you not?—Yes.

2139. Are you accustomed to set up engines for pumping?—I am; I have erected a great number in London and elsewhere, and in every part of the world almost. The first pumping engine which I erected in London was 22 years ago.

2140. All coarse substances larger than grit being excluded from the sewage, could you pump it 300 or 400 feet at one lift?—No.

2141. What is the greatest height to which you could pump it, with Cornish engines, at one lift?—I should not recommend at all more than 200 feet.

2142. Do you mean that the engine would be 200 feet above the level of the water that you would lift?—The water should be lifted 200 feet where it is taken from; but if it is lifted more than that I should recommend a second pump.

2143. Do you put the engine on the low level, and force the water up?—Yes.

2144. Then would the maximum height to which the sewage could be lifted with one set of engines and pumps be 200 feet?—Yes; we might take it 300 feet; but in that case the pumps must be made so strong that the two pumps together would not cost as much as the one pump; in consequence of the great column of water the parts must be made very stout, for fear of bursting the pumps.

2145. If you are given the height to which you must lift the water, and the quantity of liquid, and the time in which you must lift it, how do you calculate the horse power required?—Upon the Cornish engines we calculate 16 lbs. on the square inch of the steam piston, and then we divide by 33,000 lbs. lifted one foot high, which will give the horse power.

2146. Is that the gross horse power, or the net horse power?—That is the actual horse power; the nominal horse power is very little more than half of that.

2147. Is that the same as what is called the gross horse power?—Yes.

2148. What is the cost of erecting engines per horse power, including the buildings, and the pumps, and all the necessary fittings, per horse power?—Exclusive of buildings, the Cornish engine, erected complete with boilers, would cost about 35 *l.* per horse power.

2149. And if you have the engines in duplicate, what will be the cost?—If you had the engines in duplicate, then you would not want any more boilers for the pair of engines than you would for one, and by that you can save upon the duplicate engine 5 *l.* for every horse power; say 30 *l.* upon the second engine.

2150. If you had more than two engines, what would be the cost?—If you had more than two engines at one place then it would come a little less still, but not a great deal less.

2151. Have you a detailed estimate there in your hand?—Yes; 200 feet can be pumped at one lift, or you may divide the 300 feet or 400 feet into two lifts. Cornish pumping engines, including boilers, erected complete, but exclusive of pumps and buildings, will cost 35 *l.* per actual horse power. I cannot estimate the cost of buildings, not knowing the cost of foundations, &c. When in duplicate they will cost 30 *l.* per actual horse power. For all heights less than 30 feet, the single acting drawing pump would be used, and above this height the plunger forcing pump. The valves should be on the principle of Harvey and West's double beat valves. The cost of lifting 1,000 tons 50 feet high, will be 2 *s.* 4 *d.*, and for every 50 feet 2 *s.* 4 *d.* must be added; therefore to lift this quantity 100 feet will cost 4 *s.* 8 *d.*; 200 feet 9 *s.* 4 *d.*; 300 feet 14 *s.*; and 500 feet 23 *s.* 4 *d.* The above includes coal, labour, oil, tallow, and hemp. The cost of lifting one ton is very little; 4½ tons can be lifted 500 feet high for one penny. I would recommend a brass sieve, made in the form of a basket, to be placed at the bottom of the well, through which all the fluid should pass before arriving at the entrance of the suction pipe; the sieve to be so mechanically arranged for hauling to the surface for clearing.

2152. Is the price which you have stated for the actual horse power, or for the nominal horse power?—For the actual horse power.

2153. What kind of pumps and valves do you recommend?—If the lift is not exceeding 30 feet, I should recommend the plain drawing pump with a single bucket and single tackle. If it is more than 30 feet, I should recommend the plunger forcing pumps.

2154. Can you state the price of lifting 1,000 tons of liquid in 10 hours through 50 feet?—The cost of lifting 1,000 tons of liquid 50 feet high will be 2 *s.* 4 *d.*, for the first 50 feet, and for every 50 feet, 2 *s.* 4 *d.* must be added.

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W. West.
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2155. Lifted in what time?—We have taken the pump to work 100 feet, or to lift 100 feet for the size of the pump, every minute. The engine will go 200 feet, but those are single acting pumps.

2156. Do you mean that there is an increasing rate as you go on?—Two shillings and four pence is added for every 50 feet after the first.

2157. Then will 150 feet cost three times 2 *s.* 4 *d.*, and 200 feet four times 2 *s.* 4 *d.*?—Yes, and 500 feet would be ten times 2 *s.* 4 *d.*

2158. Mr. *Caird.*] What would be the cost of lifting it 500 feet?—Twenty-three shillings and four pence.

2159. *Chairman.*] Then what is the cost of lifting liquid per ton?—We cannot find a cipher for it.

2160. Is it a very small decimal?—Yes.

2161. What would you propose to prevent the valves from getting choked or injured by foreign substances?—I should recommend a brass wire sieve made in the form of a basket, which would be worked in guides in the shaft, and all the fluid should pass through that basket so as to take out any large substance or old rags, or clothing, or cats, or dogs, or anything of that kind; and that basket should be lifted to the surface, or to some convenient place, as often as was required to cleanse it.

2162. Would all those substances remain in the wire-basket, and then would it be lifted to the surface and emptied?—Yes, it is very easily arranged.

2163. Can you give us any information of the relative cost of the carriage of any substance, such as clay, in a cart, or by suspension in water, by means of pumping?—That will make no difference at all, because we are pumping all the china clay in St. Austell, which is about 200,000 tons a year, and that is thicker than the mud of the Thames, and it does not interfere with the valves at all, as long as it is in a liquid state. We pump the mineral water in some of the mines also; half of that is entirely what we call mud.

2164. Supposing that the clay were mixed with the water and pumped up, and lifted, as you say, to a certain height, and then allowed to gravitate in mains, would it be cheaper to take a great quantity of clay in that way, or to take it in a dry state by means of carts?—If once you can get it in a liquid state, there is no cheaper mode of conveying it than by water. We convey our clay for miles by pipes, and save all our carriage.

2165. Mr. *Caird.*] Then the muddiness of the sewage would not, in your opinion, at all obstruct the action of the pumps?—Not at all.

2166. And the only thing to provide against would be any solid matter getting in?—Anything that is hard, or old clothing, or anything in that way. I have myself, in London, seen a sheep in the sewage, and seen it taken out; I was present when it was done.

2167. And do you think that all such substances will be practically excluded from the pipes by the use of this screen?—By the use of this sieve, which should fit into a well, and all the sewage should be emptied into that sieve, and that should be so mechanically arranged that when it is wanted it may be cleansed, so that you may make sure that no hard substance would ever go into the clack.

2168. You speak of carrying clay through pipes for some considerable distance; do you do that?—Yes, for miles we are doing it entirely with the clay merchants in the neighbourhood of St. Austell; and St. Stephen's are carrying, perhaps, 20,000 tons a year in that way for two or three miles to save land carriage.

2169. Is that clay pumped out of the mines?—No, it is raised out of a granite country for making china. We first pump all the clay, and water, and sand out of the pits, and then it is washed, and then the clay is carried as a lighter substance away for two or three miles in a good many places.

2170. Then the water becomes a cheap vehicle for the carriage of clay?—Yes, it does, if you have ever so little an incline; a quarter of an inch upon a hundred fathoms is quite sufficient to carry it.

2171. Then you do not require the action of a pump?—Not at all, when you can send it through a pipe; if you have a little incline it is sure to go on with the water.

2172. Does not the sediment deposit itself and obstruct the pipe?—Not at all, if you have a quarter of an inch of declivity in 100 fathoms.

2173. *Chairman.*] Are you aware of a fact which is mentioned in the report of the Board of Health of 1852, of a large reservoir which had silted up to the depth of four feet being cleaned out by pumping?—I have heard of it.

2174. And it was found to be cheaper to puddle this water and pump it out, than to cart it out; do you believe that?—I believe that, certainly.

2175. Mr. *Caird.*] Does your estimate of the cost of pumping depend upon a given price of coals?—Yes, entirely so.

2176. What do you give as the price of the coal?—I calculate the coals would cost 1 *l.* per ton, which is quite sufficient.

2177. And is your estimate based upon a price of coal of 1 *l.* per ton?—Yes.

2178. Mr. *Hibbert.*] You have stated that that liquid clay is conveyed in pipes by gravitation; what distance is it so conveyed?—From two to three miles, in several places; I have one gentleman close by my land now, about two miles off, who is a large clay merchant, and he tells me that he saves something like 800 *l.* a year by carrying the clay in this manner.

2179. Is there more difficulty in conveying sewage than clay?—Not so much; I am certain of that, because I have great experience in pumping out of the Thames?—I erected the first engine at the East London Waterworks 22 years ago, and when I erected that engine I saved them 4,600 *l.* a year in cost.

2180. Mr. *Tite.*] That was under Mr. Wicksteed?—Yes.

2181. He promoted the use of Cornish engines very greatly, did he not?—Yes.

Mr. JOHN HOCKING, called in; and Examined.

Mr.
J. Hocking.
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2182. *Chairman.*) You are a Partner in the well known firm of Hocking & Son, of Redruth, in Cornwall, are you not?—Yes.

2183. Do you carry on business at Redruth, as engineers and founders?—We are not founders; we are engineers.

2184. You

Mr. *J. Hocking.*

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2184. You are employed in designing and erecting pumping engines chiefly, are you not?—Yes.

2184*. On a very extensive scale?—Yes.

2185. Has your firm been engaged many years in Cornwall?—Yes, upwards of 30 years.

2186. You have erected pumping engines all over Great Britain, have you not?—Yes, in nearly every part of the world.

2187. And also in North and South America and Australia?—Yes.

2188. Assuming that all foreign substances are excluded from the sewage, could it be pumped up in the same way that water is pumped?—Without the least difficulty.

2189. Would fine sand or grit interfere with the pumping at all?—If it was not in the shape of stone, fine sand, or anything of that sort, would pass through; that is continually the case in pumping.

2190. But if it had passed before through the pumps, as would be the case in London, then would there be anything in that sewage which could hinder your pumping it again?—There is nothing but what could be easily removed.

2191. What is the cost per horse power of erecting Cornish engines and pumps, including all the necessary buildings and engine-houses?—Supposing there was no increased cost or difficulty in getting the foundations, it would be from 50 *l.* to 55 *l.* per horse power.

2192. Does that cover every cost?—Yes.

2193. Is that the average price applicable to any part of the kingdom?—Yes.

2194. But of course it would be cheaper nearer Cornwall?—Of course it would; we could get materials cheaper.

2195. The only difference being the freight, in fact?—Yes, and a little decreased labour cost.

2196. Is that the price for actual or gross horse power?—Actual horse power.

2197. What is the difference between gross and net horse power?—About 30 to 40 per cent.

2198. What would be the cost of lifting a ton of liquid 300 feet high?—A ton is an exceedingly small quantity; I have made it at per 1,000 tons; and for that we calculate that it would be from 12 *s.* to 14 *s.*, assuming that coal could be got at 15 *s.* to 17 *s.* per ton.

2199. What would be the cost of lifting 1,000 tons 50 feet high?—One-sixth part of that; it would be in the same ratio whatever the height might be.

2200. Then is it always exactly in the same proportion?—Yes.

2201. Then for lifting 300 feet would it cost six times what it would cost for 50 feet, and for 150 feet three times what it would cost for 50 feet?—Yes.

2202. Is what you have given the cost of working the engines?—Engines, coal, labour, oil, tallow, and everything, in fact.

2203. If the coal were a little dearer would the difference in cost be only due to that difference?—That is all.

2204. For instance, if coal were 20 *s.* a ton, would the cost be just 3 *s.* more?—Yes. The proportion, if coal were 20 *s.* a ton, would be about 2 *s.* 4 *d.* per 1,000 tons; that would be about 14 *s.* for 1,000 tons lifted 300 feet high, or at the rate of 32 *l.* per 10,000 cubic feet for every 50 feet high.

2205. Mr. *Hibbert.*] Have you had any experience of the passage of liquid clay through the pipes?—No, I have had no experience of that.

2206. Mr. *Caird.*] Did we correctly understand you to state that there is no additional cost in pumping liquid, after you reach 50 feet, for the next 50 feet; is it not a greater cost for the second 50 feet than for the first 50 feet?—Supposing that the first 50 feet costs 2 *s.* 3 *d.*, 50 feet more would cost 4 *s.* 6 *d.*, and the next 50 feet would be 2 *s.* 3 *d.* more.

2207. You would estimate 2 *s.* 3 *d.* for every 50 feet?—Yes.

2208. It does not increase in any increasing ratio?—No. In fact I believe it would diminish a little when we get to a height of 200 feet.

2209. Mr. *Tite.*] You stated that if the coal were dearer as between your average of 17 *s.* and 20 *s.*, that would increase the cost of lifting; are there not other elements besides coal, such as wear and labour?—We have calculated for labour the price which is generally paid in this neighbourhood, but the increased price for lifting would not increase in the same ratio as the price of coal increased.

2210. Nor would the wear-and-tear of the engines?—No.

2211. Then should we have simply to add the additional cost of the coal?—Yes.

2212. *Chairman.*] What is the maximum height to which you can lift the sewage?—It could be lifted 300 feet at one lift, but I do not think it would be advisable to lift it to that height at one time.

2213. Would it require much stronger pumps for that height?—Yes.

2214. You would require other engines, and another reservoir at the next lift, would you not?—Yes.

Mr. CUTHBERT W. JOHNSON, called in; and Examined.

Mr. *C. W. Johnson.*

2215. *Chairman.*] YOU are the Chairman of the Local Board at Croydon, are you not?—I am.

2216. Were you one of the Commissioners of Sewers in 1852?—Yes, I was.

2217. How many inhabitants has Croydon?—The parish has 30,000; but the town, about which the Committee are most concerned in this inquiry, has about 15,000 or 20,000.

2218. Was it those 15,000 or 20,000 inhabitants whose sewage used to flow into the river?—It did.

2219. The volume of that sewage was, how much?—From 800,000 to 1,000,000 gallons per day.

2220. The volume of the sewage was about one-twentieth of the volume of the river, was it not?—I should say it bore a larger proportion to the volume of the river than that.

2221. Could you give us the proportion?—I should think that the volume of the river was not more than five or six times the volume of the sewage; I am speaking of ordinary times, when there is no extraordinary rainfall.

2222. Were there not several injunctions granted against the Local Board of Croydon?—Several.

2223. Was that because of the fouling of the river?—Yes, chiefly.

2224. And had you not to defend some rather

Mr. *C. W. Johnson.*

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expensive lawsuits also?—We had, at an expense of several thousand pounds, including the great cause, which was divided into two parts: first, as to the water from our well, which the millers endeavoured to stop us from taking; and, secondly, because we fouled the river with the sewage. In the first portion of that great contest we succeeded as to taking the water from our well; that, the House of Lords determined we had a right to do; but in the other portion we had to take measures to prevent the fouling of the river by the sewage.

2225. One of those injunctions was granted in January 1862, was it not, by Vice Chancellor Sir William Page Wood?—It was.

2226. Do you remember whether he stated in his judgment that it had been proved in evidence that irrigation perfectly cleansed the sewage, and that it flowed off the grass as pure water; whence he concluded that the irrigation system of Croydon must be in some way defective, and that on that ground he granted the injunction to Mr. Bidder?—He expressed himself to that effect.

2227. The sewage of the town is now successfully applied in irrigation, is it not?—Quite so.

2228. And pure water flows into the river?—Nearly pure; as pure as ordinary river water usually is.

2229. Till 1857 the sewage was applied to 15 acres of land, was it not?—To some very small proportion.

2230. And the land was then covered, in consequence, with mud, which stank, and proved offensive; was not that the case?—It was so.

2231. In 1860 it was applied to 56 acres, was it not?—Yes, to a larger quantity of land.

2232. Was that land also "overdone" with the sewage water?—It was.

2233. And in 1862 did you apply it to 240 acres of land?—Somewhere about that; 240 acres or 260 acres.

2234. To how much land do you apply it now?—To about the same amount.

2235. Does any nuisance arise from those meadows to which it is now applied?—Not any.

2236. Is it applied to any other crop besides grass?—To hardly any; they are trying it this year upon one or two things, but it is grass chiefly upon which we have tried it; that is the chief thing that it is adapted for.

2237. Why do you not adhere to the grass?—The farmer who has it, Mr. Marriage, who is a very intelligent man, tries experiments with it; and now he is going to try it (with, I fear, very doubtful results) to some mangold.

2238. Is the grass covered with a stinking mud now?—No.

2239. How often do you apply the sewage during the year?—It is applied, upon the average, about every 10 or 12 days.

2240. And what is done with the sewage in the meanwhile, when it is not being applied?—It is obliged to go over the land every day, because the Committee will remember that we have two great objects to accomplish; the first is the sanitary part of the matter, to purify the sewage; and therefore the tenant, whether he wishes to have so large a quantity of sewage or not, must use it, for he is bound to purify it before he lets it flow off the land into the river.

2241. Then does he take those 800,000 or 1,000,000 gallons every day in the year?—He takes it every day in the year.

2242. Then how do you mean that he only applies the sewage every 10 or 12 days?—Perhaps 30 or 40 acres are irrigated at a time; the sewage will be flowing over those 30 or 40 acres for two or three days, and then, when he thinks there is as much as the grass will bear, it is carried on to other lands.

2243. Then its turn comes every 10 days?—About every 10 days.

2244. Lord *Fermoy.*] Do you find the application of the sewage profitable, as regards agricultural use?—Decidedly so; the tenant gets about four crops of grass in a year, and those crops will certainly average from 12 to 14 tons per acre; and he sells it to the cowkeepers, as it stands on the ground, at 8 *l.* a crop. Therefore if a farmer gets, without any outlay whatever except his rent, 32 *l.* per acre receipt, I need not explain to the Committee that that is a profitable operation.

2245. Had you to embark much capital in bringing the sewage upon this land?—There was the construction of the sewer, which is partly covered and partly open, but chiefly open, which is, perhaps, about a mile long; and there was the formation of some kind of rough filtering places to take out the coarse matters of the sewage and the mud, which was formerly offensive; that expense had to be incurred, and then we had to prepare the ground for irrigation; that had to be levelled, and I think we allowed the tenant some 3 *l.* or 4 *l.* an acre for that purpose.

2246. How do you mean as to what you call the coarse filtering?—There are some large tanks, in which the sewage flows at one end and out at the other, through a coarse filter, which is composed of some coarse gravel and straw, merely to take out that rough mechanically suspended matters.

2247. Are those tanks covered over?—No, they are open,

2248. Is there any bad smell from them?—No; there is a smell, but nothing that is offensive to the neighbourhood. When sewage is brought out of a town with sufficient rapidity, as it is in the case of Croydon, through glazed pipes, there is no time for decomposition to set in. The public at large, who get their knowledge of sewage from what they see in very ill-conducted sewers, have a very wrong impression of what sewage really is.

2249. Mr. *Tite.*] Is the system of drainage of Croydon the usual system, ending finally in one outfall sewer?—Yes.

2250. When the outfall sewer has ended its work as a sewer, is there any tank or receptacle to receive the sewage water at the end of the sewer, or how is it mechanically managed to get it on to this land?—There are two settling ponds made, which are lined with brick, and are longer than they are broad, and it flows in at one end and flows out at the other, through some coarse straw and filtering matters, perhaps for a week or a fortnight; and it is turned into one settling pond while the other is cleansed out from the mechanically suspended matters which have subsided, and that is sold to the neighbouring farmers.

2251. Are those ponds covered?—No; they are open reservoirs.

2252. Is the solid matter which is deposited in the shape of the usual sewage mud cleared out, then, once a fortnight?—Something like that; occasionally.

2253. And is it carted away, or how is it managed?—It is carted away by the adjoining owners of land.

2254. Is

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2254. Is it in the shape of mud?—It comes out as mud, but by resting for a short time on the ground, it solidifies sufficiently to be moved with a shovel.

2255. We have now got as far as the tank, and in order to collect anything, apparently, beyond that, which would naturally subside, there is a sort of rough filtration established; is that so?—Yes.

2256. Does it go over the land next; how is it distributed over the land?—It flows out from the end of those settling tanks into an open channel until it arrives at the ground, which is some short distance off, and then it flows about, as directed by carrier-drains, all over those 250 acres.

2257. There is no mechanical means of distributing it, is there, like a hose, or anything of that sort?—Nothing of that sort.

2258. Is that natural or artificial grass which is grown on the land so irrigated?—It is both; the largest portion, I take it, is Italian rye grass, which they find yields the largest crops.

2259. Does it then distribute itself by the natural effect of gravity over the land?—Yes.

2260. Is it again collected, to carry off the service water?—It is collected into the outfall channels, but then it becomes quite bright; and finally, through a variety of minor channels, it unites in our large main channels, or open ditches, and then it flows into the River Wandle.

2261. With regard to very heavy rainfalls, how do you manage them?—Then the quantity is considerably increased, and still Mr. Marriage has to provide for it all. We, being on the chalk formation, are not so subject to this flood-water as they would be, perhaps, in other places, because the water in the chalk sinks into it; it does not flow off the surface much.

2262. It is absorbed by the chalk, is it not?—Yes.

2263. I presume that the natural circumstances must be very much in your favour; that is, that those points where the sewage is collected are at the top of the land, and that it flows naturally down to the bottom; is that so?—There is not a very great difference in level; there is a certain fall, and we have no difficulty in conducting it about by its own gravity.

2264. Of course the River Wandle is in the valley?—Yes.

2265. Does the farmer pay you anything for this sewage?—Yes.

2266. In what way does he pay you?—In the shape of rent; the land does not belong to the town, it is hired on lease, and we pay for it a rent of 4 *l.* an acre.

2267. Is that the ordinary rent for such land?—It is too much.

2268. It is a good price?—It is a good price; they knew we were obliged to have some land, and therefore they charged more for it, and then we let it to Mr. Marriage at an increased rent of 5 *l.* an acre.

2269. Then you get 250 *l.* a year by the operation, do you not?—We do at present.

2270. Do you get anything from the solid sewage which is raked out and carted?—One shilling to 1 *s.* 6 *d.* a ton, but that is comparatively of very little value.

2271. On the whole, does the town of Croydon get anything by this arrangement, beyond the effects which you have described of getting rid of a great offence; do you get any money in your pockets by it?—Yes; that rent goes to the diminution of our other rates.

2272. But is there not some expense in maintaining all those ponds, and raking them out, and so on?—The settled matter, the solid manure, I take it, would about pay for all the labour in attending to the works, and in levelling; and the 250*l.* a year is nearly clear profit, or about that. The Committee must understand that in our case we have not been in a position to take so much advantage of this plan as we shall hereafter; because, with an injunction hanging over us, we were forced to get hold of the first land that we could get possession of, and we were glad to get a tenant to take it; otherwise we should get a much larger rent.

2273. Is the land held by the parish on lease, in the first instance, and is the lease of the sub-lessee co-existent with your undertaking?—I think it is, but I am not certain.

2274. What was the nature of this injunction obtained by Mr. Bidder, the engineer?—Several persons applied, one after another; there were several injunctions.

2275. What was the complaint that was made?—It was that we poured the sewage into the River Wandle, and created a nuisance.

2276. It was not that you distributed it over the land?—That had nothing to do with it.

2277. Who suggested this remedy of pouring it over the land, and thereby depriving it of its noxious qualities?—I think it was myself. I had used it for a long while myself on my own ground, in a small way; that was merely the sewage of the house.

2278. Have you had any complaints since?—No.

2279. Are the fish in the Wandle in existence, as they used to be?—Yes. Mr. Smee and Mr. Gurney have got some breeding-grounds now; and lest the Committee should fancy that I am concealing anything, I should state that there was a complaint against us, about a fortnight ago, that we had injured Mr. Smee's breeding-boxes. He stated that there was some gas-tar which came down from our sewers; but it came out, by strict examination, that we had nothing to do with that, and that it was owing to some men whom they had been prosecuting for poaching in the river, and who had poured some tar in for the express purpose of injuring the fish.

2280. That had nothing to do with you?—No; that had nothing to do with us.

2281. Mr. *Ferrand.*] You have stated that the sewage of Croydon averages about 1,000,000 gallons a day, and that it is applied to about 250 acres of land; is it your opinion that that sewage could be applied with advantage to a larger amount of land, if you had it in your possession?—I think it could.

2282. You stated, did you not, that it goes over the land about once in every 10 days?—Yes.

2283. When you state that, do you mean that it is applied to the same land once in every 10 days?—About that, upon the average, for the reason I have stated; Mr. Marriage is obliged, sometimes, to use it when he does not think the land requires it.

2284. How many years have you been applying the sewage to the same land?—About three or four years.

2285. Do you find that it is growing richer in its productions every year?—I should say, decidedly, it was.

2286. Then it bears out your proposition that if you had a considerably larger amount of land

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you could apply this sewage to it advantageously?—I think so; the sewage must be applied in large quantities to do any good; it is useless in small quantities.

2287. Mr. *Tite.*] Do you mean that there is no limit to its application?—No; I mean that unless you apply it in a large quantity, from 3,000 to 6,000 tons an acre for grass land, for which I take it it is chiefly adapted, the maximum benefit is not obtained.

2288. Mr. *Ferrand.*] Are you not aware that land may become tillage-sick, as well as too poor?—I do not know that in the case of grass I ever knew land too rich; in the cultivation of cereals or roots you might get them, perhaps, too rank.

2289. Do you mean by grass land that you mow the grass and take it off the ground to be consumed elsewhere?—Yes.

2290. Are you not aware that grass land may be tilled to so large an extent that the crop may be so heavy as to prevent its being made into hay on the ground?—I never knew of a case of that sort; but I take it that, in those localities where the sewage would be applied, its chief use will be for the feeding of stock; and I take it that the grass is so very valuable for milch cows, for instance, that in the vast variety of instances the sewage will be absorbed by the land.

2291. Have you calculated how many tons an acre you are now applying in the year to your grass land?—I have not calculated exactly, but I should think that we are applying about 4,000 or 5,000 tons; I do not give that as an accurate calculation, but I think it is about that annually now.

2292. Then you are applying 4,000 or 5,000 tons annually, and you state that the land is growing richer annually; is that so?—Yes.

2293. And do you state also that you could supply the 1,000,000 gallons of sewage a day advantageously to a far greater amount of land than 240 acres?—I should not say a far greater amount.

2294. To what amount?—I should think, perhaps, to the extent of another 50 or 100 acres; we have 300 acres on the farm at present, but the sewage has only been applied to 250 acres as yet.

2295. Then do you think that sewage to the extent of 2,000 tons a year per acre might be of advantage?—I should think it would; that would be equal to a rainfall of 20 inches.

2296. You have stated that your sewers upon the land are chiefly open; are they made by spade or by plough?—By spade; they are too large to be made by plough.

2297. What breadth are they?—I should say that the main carrier-sewers must be five or six feet across.

2298. My question referred to the open drains by which you apply the sewage to the farm generally, and not the main conductors on the top of the lands?—They are done chiefly, I believe, by the spade; but they are small, not like those that I was referring to; they are only, perhaps, about a foot or 18 inches in breadth.

2299. And what depth are they?—Not above a foot, I should say.

2300. Have you tried the application of the plough to make those open drains?—I am not able to state whether Mr. Marriage has ever used the plough; I should suppose that it would facilitate the thing a little, but it would not be much, because it wants so much trimming up.

2301. Would you be surprised if I tell you that the plough is used entirely in my part of the country, and is found to apply the sewage to the land effectually?—No, I should not; I should think that it is very likely.

2302. If the plough will do the work with a single horse, must it not be far cheaper than using the spade?—Decidedly.

2303. You have stated, have you not, that you have used the sewage on your own ground for grass?—Yes.

2304. And you have not seen it used for corn, turnips, and mangolds?—No.

2305. Mr. *Hibbert.*] You state that you apply from 4,000 tons to 5,000 tons of sewage per acre over this land, and that you do not consider that to be too large a quantity; would not it very much depend upon the strength of the sewage whether it was too large or too small a quantity that is so applied?—Yes, it would.

2306. Do you know what the difference between the sewage of Croydon and the sewage of London is as to strength?—I believe that you find, in the analysis given by Professor Way and others, that they are pretty much of the same strength upon an average; when you get different samples of sewage from different sewers and in different seasons, of course it varies, because the rainfall influences it.

2307. Would not a larger population produce a stronger sewage than a smaller population?—Yes, it would.

2308. Are you aware that they apply from 5,000 to 6,000 tons per acre per annum at Rugby, and that those experiments have not been successful?—I am not aware of that.

2309. You state that the farmer gets about 8 *l.* for each crop per acre; is that a mere average price, or does he get a higher price for the first crop and so on, down to the fourth crop?—No; I am told that he takes the same price for the fourth crop, and, which seems a little curious, he has the greatest difficulty in selling the first crop of grass. You would naturally suppose that it would be got rid of easily, because spring-feed is scarce; but it seems that then there is a great quantity of potatoes in the market, and that hinders the sale of the grass.

2310. Is the first crop ready to cut much earlier than the crops on the generality of grass land?—Considerably.

2311. How much earlier?—I should say a month.

2312. Would not that add considerably to the value of land?—Yes.

2313. When is the first crop ready?—I think in March; I am not pretending to be accurate, but I should say about March. I am told that when they begin cutting, of course they commence some fields first; and in those fields which were first cleared of the first crop of grass, the second crop is now two feet high.

2314. Is the land ever in a fit state to turn cattle upon?—Yes, it is soon dried; Mr. Marriage keeps some 40 or 50 cows.

2315. What distance is the land from the town of Croydon?—About a mile or a mile and a quarter.

2316. You state that the sewage is conveyed to this land by a sewer, partly open and partly closed; has it ever been complained that there is any nuisance arising from that?—I am not aware that there has been any complaint.

2317. Have you ever had any complaints about the

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the sewage at all since its application to this grassland?—Formerly, before it was applied to the grass, and when it was applied to a small quantity of land, that was so.

2318. But since you have had it applied to a larger surface, have there been any complaints?—We have not had any complaints.

2319. Did not you state that the River Wandle was now purer than before?—It is purer than it was before we commenced laying down sewers at all.

2320. Mr. *Caird.*] Does the grass obtain a ready sale?—Yes.

2321. Is it sold in London?—Yes; I am told that Mr. Marriage delivers it in London at 25 *s.* a ton, green.

2322. How many inhabitants are there in Croydon from whom this sewage is obtained?—I suppose about 17,000; it is between 15,000 and 20,000; our population increases rapidly.

2323. Do you think that there is sewage enough to be profitably applied over a larger extent of ground than at present?—Yes.

2324. You think, do you not, that it might be applied over 300 acres instead of 240 acres?—Yes.

2325. Have you calculated how many tons an acre, computing the delivery at from 800,000 gallons to 1,000,000 gallons per day, may be applied in the course of the year?—No, I have not.

2326. Have you calculated that the sewage arising from a certain number of persons of the population can be applied to any given number of acres of land?—No, I have not; but it is very easily calculated.

2327. You state that in the quantity in which the sewage is now applied, it flows off clear and bright from the land, and that it is no longer a nuisance to the river; is that so?—Yes, that is so.

2328. Does it flow into the river in such a state that the fish do not die from it?—Yes; they come up close to the outlet.

2329. Is there any nuisance to the neighbourhood from the application of this sewage to the surface of the land in warm weather?—No.

2330. Has there been no complaint made by anybody as to that?—We have not had any complaint.

2331. In short, no one has found it necessary to make any complaint in consequence of the nuisance which may be alleged to have arisen from the application of so large a quantity of sewage on the surface of the ground?—A gentleman, whom everybody knows by name, Mr. Gurney, has a mill there; he wished to have it diverted from his milldam; but within the last few hours he has given us to understand that he wishes to have it back in his milldam; so that he thinks that there is no nuisance from the water.

2332. I have estimated the quantity of sewage which flows through the sewers, taking it at 800,000 gallons a day, to amount to 5,400 tons an acre as the annual application; are you aware whether that is anything like it?—I should think it was about that; I was calculating as I came along that something like 4,000 tons a day rushes out of the sewers.

2333. And you think that up to that quantity of 5400 tons an acre, it is profitably applied to the land?—Yes

2334. Are the Committee to understand that you think that it is not wastefully applied to the land?—I think it might do with a little less, but not much less.

2335. Do you think it would do with 500 tons to the acre?—No.

2336. Have you ever seen any result following the application of sewage to grass land, at the rate of 500 tons to the acre; have you ever seen that quantity tried?—I have not.

2337. Have you yourself accurately observed the result of the application of sewage in large quantities to grass land?—Yes, those fields are within two miles of my own house.

2338. You state that you at present realize 1 *l.* an acre as a profit or a return for the whole quantity of sewage that is used; is that so?—Yes.

2339. Are you likely very much to increase that in future?—I should say so; most decidedly.

2340. Have you ever estimated to what amount you may probably increase that?—It is merely a matter of calculation; but if we could get the same land at the same price, and we could then have the power of re-letting it, we should get, I dare say, from 10 *l.* to 15 *l.* an acre. We can only judge from the same data that the Committee can, that if 30 *l.* worth of grass is selling off per acre, that land is worth so much rent.

2341. What has been the cost per acre preparing the land for the application of the sewage?—We allowed 3 *l.* or 4 *l.* per acre for the levelling, and there were a good many woods to be grubbed out, and shaws to be removed.

2342. Is the sewage applied by a system of open cuts?—Yes.

2343. Not by pipes or hose?—No.

2344. Has it been found very greatly to increase the produce of the natural crops of grass growing on the ground?—Yes.

2345. Is it at this moment chiefly applied to the natural grass, or to the sown Italian ryegrass?—I cannot pretend to be very accurate on that point; there is a large breadth of natural grass, and a very large breadth where the Italian ryegrass is sown.

2346. With regard to the composition of the sewage of Croydon, as compared with that of London, you state that it has been carefully analysed; does that analysis show that the sewage of London and the sewage of Croydon are nearly equivalent?—I think so. I should have the impression that ours would be rather weaker than that of London, because our supply of water is so much better.

2347. Mr. *Tite.*] Who made that analysis?—Professor Way.

2348. Do you know exactly the population from which this sewage comes?—I think, about 17,000. Our parish is increasing at the rate of about 2,500 a year, and one can hardly estimate from one census to another whether they are out of the sewered district or in the district.

2349. Taking it at 17,000, and applying the sewage from 17,000 people upon 300 acres of land, would it not seem to follow that about one acre of land is sufficient to absorb the sewage of 60 people, according to the population of Croydon?—It works out so.

2350. May we take it then that in that proportion you find that the sewage of Croydon is satisfactorily disposed of?—Yes.

2351. Sir *William Russell.*] Before your works were altered, was there a considerable deposit on the sides of the River Wandle?—No, it was not

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so much that as the disagreeable nature of the appearance of the banks, there was a great quantity of paper and other matter which went down it, and it was very unsightly; they made, of course, more of it than was really necessary.

2352. Now there is no sort of pollution whatever is there?—That is intercepted by those settling tanks and strainers.

2353. Mr. *Tite.*] You had great difficulties in the draining of Croydon, had you not?—We had great difficulties.

2354. What was the cause of those difficulties. Mr. Page, the engineer, reported against the drainage of Croydon, did he not?—Yes; we were the very first almost of all the towns who adopted the Local Government Act—the General Public Health Act. We were then, perhaps, a little too much under the control of the then General Board, and we were obliged to put in pipes under their direction which turned out a little too small.

2355. Is all that put right now?—Yes.

2356. Mr. *Hibbert.*] As the application of this sewage has been so successful to your own farm; has there been any application for the sewage from adjoining farms?—We have no power; we have had intimations and applications that some of the adjoining farms would take it, but Mr. Marriage has got it and covenants to take it all.

2357. But you say that he is compelled to take it, whether he wants it or not; could you get the other farmers to take it?—I should say there would not be the slightest difficulty, because, although the farmers did not like the notion at first; they now tell a different story.

2358. *Chairman.*] They have found out the value of the sewage?—Yes.

2359. Mr. *Ferrand.*] Then, if Mr. Marriage finds that he has more sewage than the land would take, has he the power of selling it to other farmers, with a profit to himself?—He might do so if we allowed him.

2360. Cannot he do it without you allowing him?—Without looking at his lease I could hardly answer that question.

2361. Have you an Act of Parliament to carry out this utilization of the sewage?—Not a special Act; it is only done under the General Public Health Act, and that gives us quite abundant powers.

2362. If that is the case why cannot Mr. Marriage sell the overplus of the sewage?—If the town, for instance, was now so increased that there was such a supply as he could not possibly accommodate, then we must get or allow some other farmer to take it.

2363. Did I rightly understand you to state that you had sewage now that you could supply to 50 additional acres of land?—I should think we have, that is to say at certain seasons, when there is a heavy rainfall, it comes down in a large quantity, and then Mr. Marriage has a difficulty in using it all, and in sufficiently purifying it.

2364. When he has a difficulty in purifying it, what becomes of it?—He is obliged to pass it over land which, perhaps, in an agricultural sense, does not need it, and then, of course, the grass purifies it.

2365. But when land has received as much tillage as it can take, what becomes of the remainder?—We have never attained that position yet. Of course, if there was such a supply that the land could not take it, it must go into the river unpurified; but we have never arrived at that point yet, speaking in an agricultural sense.

2366. Mr. *Tite.*] Are you at all inconvenienced by the state of the season; by a long frost, or by the exceeding wetness of the season?—No.

2367. So far as the nature of the weather permits, does the use of the sewage still go on?—Yes, so far as the weather permits.

2368. But are not those ponds which you speak of not being covered frozen to a considerable thickness?—No, we are not troubled with ice on the river Wandle; the Wandle never freezes; the water rises out of the chalk, at a temperature of 50 degrees, and therefore we have no trouble of that sort.

2369. But does not the sewage in the ponds freeze?—We never had any practical difficulty in that way.

2370. You have suggested this scheme yourself, which appears to me eminently successful: have you any pursuit yourself, or are you merely a country gentleman?—I am a member of the Bar.

2371. Therefore that suggestion must have arisen from your own experience and reading on the subject?—Yes, and from having from a boy paid considerable attention to agricultural matters.

2372. In your own case, do you apply always in the same way?—Yes, the sewage of the house; 20 years ago I commenced, and have ever since applied it to perhaps half an acre of grass, with the same success which has followed the larger experiments.

2373. Do you believe that if the farmers could be persuaded to take the sewage on a large scale, they would derive benefit from the use of it?—I have not the shadow of a doubt about that with regard to grass land.

2374. You have no opinion as to its application to arable land?—No.

2375. Croydon is well placed both for the growing of that kind of crop and for the sale of it; that is to say, the supply of the Metropolis necessitates a great demand for the feeding of cows; is that so?—Yes.

2376. And this tenant of yours has a great many cows, has he not?—I think he has 40 or 50 cows.

2377. Is this Italian rye grass sold?—Yes; you may almost daily see a great bevy of carts and costermongers, and all sorts of people, taking it off the land.

2378. Is it all cut green and carried away; is there no haymaking?—No.

2379. Have you had any experience of haymaking of grass which has been so treated with sewage?—No, only in a very small way on my own plot of land.

2380. Is it at all offensive?—No.

2381. It has been suggested that in Scotland some ill consequences follow the using of hay made from grass so treated with sewage; are you aware whether or not that is so?—I know that the cattle prefer the sewage-irrigated grass to any other grass.

2382. Sir *William Russell.*] Do you consider that the sewage itself is taken up by the crop almost entirely, and so goes off; or do you think

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that it enriches the land at all?—I think that the ammoniacal and soluble portions are chiefly taken up by the plant; and that the mechanically suspended matters, which are the most worthless part of the sewage, and which generally consist of a great deal of silica, and perhaps a little alumina, are deposited on the land, and we should be just as well pleased if it was not there.

2383. All the really fruitful properties are taken up by the actual crop, and there is no additional value to the soil itself, unless you can be continually applying sewage to it; is that so?—Exactly.

2384. That is to say, if you discontinue passing the sewage over the land, the land will return to its original value?—If the mechanically suspended matter of the sewage, which we say contains some silica or some carbonate of lime in considerable quantities with it, or alumina, is deposited in a soil which is naturally deficient in any of those three earths, then it permanently improves the soil by the deposit, but if it is deposited on a soil whose earthy matters are of a similar composition to the matters suspended in the sewage, then it does no good.

2385. Mr. *Ferrand.*] Upon what data do you ground your opinion that the sewage will not answer when applied to corn crops?—The advantage of sewage, I take it, to grass is to be divided into two portions; first, the advantage of applying so much pure water; and, secondly, the application of the various matters which are mechanically suspended in, or chemically combined with, that water in the case of sewage. I take it that, in most cases, if that same bulk of water were applied to grass land, it would do a great deal of good in the majority of instances on suitable soils; but with regard to the cereals, you do not want moisture; the driest climates are the best for the most valuable of those cereals, and, therefore, when you add water to corn land, it is adding what that crop does not need.

2386. But does not corn land require the fertilising properties of sewage?—Yes; but then, I take it, that the bulk of water which would be necessary to carry those ammoniacal matters and that small amount of phosphate of lime which is contained in the sewage would be so great, that the water would be injurious to perhaps a greater extent than the chemical matters would do good to the land.

2387. But would not that depend very much upon the quality of the soil, and the drainage of the land?—It would.

2388. You have no practical knowledge on the question?—Not at all.

2389. *Chairman.*] How many injunctions and lawsuits have you suffered under, in consequence of letting the sewage run into the river?—I think about six.

2390. Can you state to the Committee the total cost of all your lawsuits and injunctions?—Yes, I can; but we do not like those matters discussed, because it is a great deal of money; it is some thousands of pounds.

2391. Do you object to go any nearer than that; would you object to state to me whether it is above 10,000 *l.*?—It is just under 10,000 *l.*

2392. Then, in fact, you have had to pay that sum, whatever it was, for letting the sewage run into the river?—Yes.

2393. And you then had to pay an additional sum for works to prevent it running into the river?—Yes.

2394. You state that you get a rent for this sewage, which goes in diminution of your rates, and that you said was about 250 *l.* a year now; is that so?—Yes.

2395. And do you also sell the matter that settles in the tanks?—Yes.

2396. How much more would that be?—I believe that there is about 1,000 tons a year sold at about 1 *s.* or 1 *s.* 6 *d.* a ton.

2397. You state that this revenue would increase rapidly if you could only get rid of your contract with Mr. Marriage?—I should have no doubt of it.

2398. Then, in fact, the state of the case is this, that while you let your sewage run into the river, you had to sustain a great loss of something like 10,000 *l.*, besides the cost of making the works, and now that you do not let it run into the River Wandle, you have a clear gain of more than 250 *l.* a year in diminution of the rates; is that statement correct?—Yes.

2399. And you are unfortunately tied down by a fixed rent, or else the ratepayers would be still better off?—Decidedly.

2400. Besides which you are now free of all injunctions and lawsuits?—Yes.

2401. For how long does this contract with Mr. Marriage endure?—I could not answer that accurately; I should think a few years more; we only have a lease for 14 years.

2402. You cannot get more land about there, can you?—We are not sure of that, but we think we may; we are looking forward to other contingencies; that we may perhaps have occasion to lift the sewage with a pump.

2403. Do not those open sewers ever stink in summer?—Slightly; but not so as to be perceptible at any distance.

2404. Do they never freeze?—I have never seen or heard of their freezing.

2405. Is that from some inherent property in the sewage?—Yes.

2406. Mr. *Tite.*] You reason scientifically with regard to arable lands and cereals, and you suggest that the finest wheat is grown in Spain and hot countries: do you imagine that that remark applies also to oats and barley?—Not to so great an extent to oats, certainly.

2407. With regard to other crops growing on arable land, such as turnips, mangel wurzel, and so forth, do not you imagine that irrigation would be useful to those crops?—I should have some little doubt about it.

2408. Mr. *Caird.*] Have you not applied the sewage yourself to any other crop but grass?—Only to the crops of the garden, such as strawberries, celery, lettuce, and asparagus, and they luxuriate in it.

2409. Have you found that the application of sewage to garden crops is very successful?—Yes, decidedly so; my gardener uses nothing else; but he keeps it quiet, because the people in the house do not like the notion.

2410. You have not applied it to mangels or turnips, except in the garden?—No.

2411. Then when you state that it would not be successfully applied to turnips and mangels, it is not from your own experience?—No; merely from my own chemical reasoning on the subject.

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2412. Mr. *Caird.*] (To Mr. *Ellis.*) You base your estimates, as I understand, on a value of 2*d.* a ton for the sewage, as compared with guano at 11*l.* a ton, and on the principle of 1,250 tons of sewage containing an equivalent amount of fertilizing matter to one ton of guano?—Yes.

2413. And you carry out that to show a value of 2,911,788*l.*, if extracted and dried, taking guano at 11*l.* per ton?—Yes.

2414. Have you computed the cost or considered the practicability of extracting and drying it?—Certainly not, because I have never attempted to do anything of the kind; it is an impossibility; we can do it in a chemist's laboratory, as a specimen, in order to ascertain the manurial strength of any quantity of sewage; but of course, in dealing with the sewage of the metropolis, or any other town, it would be an impossibility, and that has been proved over and over again.

2415. In answer to Question 1795, you say, "No manure is of any value whatever to land until it is liquified; if we do not liquify it before we apply it to the land, it remains dead upon the earth." Do you wish to modify it in any way?—That, I think, is not exactly what I meant; I wish to correct that answer. I say that no manure is of any value to a crop until it is reduced to a liquid state, because we know that the roots of plants are so constructed as to prevent the plant from taking in any solid substance; therefore all food must be presented to a plant in a liquid state. If then you apply a solid manure to the earth to nourish plants, that manure is of no value to the crop until it is liquified; and if it is to be liquified by the rain, that process is very tedious, extending over some years; so that I think that it is a gain to the farmer if he is able to liquify his manure, and apply it at once to the crop.

2416. Then we are to conclude that you consider that the sewage is more advantageously applied to the land in a liquid state, than if it were extracted and dried?—The evidence clearly proves that its value is quadrupled. I shall be prepared, if it does not fatigue the Committee, to produce proof upon proof from the evidence in support of my assertion.

2417. In answer to Question 1776, you state that certain parties have an interest in running down the value of the sewage; who are the parties who have an interest in running down the value of the sewage?—The dealers in artificial manure.

2418. Are not artificial manures used rather at a distance from great towns, than in the vicinity of great towns, to which sewage is more particularly applicable?—I do not admit that sewage is at all specially applicable to the vicinity of large towns. I contradict that position, because the vicinity of large towns is very amply supplied at present with the manure from the town; and, if we desire to obtain a good price for the sewage, we must take it to those localities that are not well supplied, that is, to a distance from towns.

2419. At Question 1796, you are asked, "Then do you differ from Professor Way when he states that manure is of no value until it is extracted and dried?" Can you state where Professor Way at any time has stated that manure is of no value until it is extracted and dried?—That is a question put to me, and not one of my answers: but I think I can show you, from Professor Way's evidence, that his opinion amounts to that.

2420. Would you show it?—Here is a little pamphlet which seems to take that as a text. At page seven of this pamphlet, published by Messrs. Napier and Hope, in support of their scheme for putting the sewage of the north side of the metropolis on a very limited area, they say, "In examining the different systems of sewage utilisation, the first and most difficult problem which presents itself is, how to dispose of the enormous volume of water with which the fertilising substance is diluted. The manurial constitutents of sewage are suitable for every description of crop. Professor Way, in his answer to Question No. 774 of the Select Committee of the House of Lords" (that should be the House of Commons) "on Town Sewage, says: If you gave me dried sewage, it would be capital manure for any crops, no matter whether wheat, or green crops, or grass; it is merely the form in which you present it, that makes it unsuitable for some crops. It strikes me that it is the same kind of thing as if a man were to owe me the value of an ounce of gold, and were to bring it to me in the shape of gold quartz, saying, here is so much gold quartz, which contains 4 *l.* 15 *s.* worth of gold, or whatever it may be; that would not be paying me at all; I should have to take it with all its disadvantages, and to get it out of the quartz.'" That, I presume, is the evidence that the Honourable Member refers to.

2421. That does not seem to bear out the opinion attributed to Professor Way, that the manure in the sewage is of no value until it is extracted and dried?—I am not responsible for the question put to me, but I think it is intended to induce the public to believe that the liquid in the sewage renders it worthless, comparatively speaking.

2422. At Question 1816, speaking of the tables of Mr. Lawes, and which are not only tables of Mr. Lawes, but of the Royal Commission which inquired into the whole matter, you say that you consider those tables to be entirely wrong, and that you think that anyone, with the least pretensions to science, would know that they were wrong. Are you aware that Professor Way and Mr. Lawes hold the highest rank in this country as agricultural chemists?—I do not go into the question of what rank they hold; I am prepared to cite the opinion of Baron Liebig, if that is entitled to carry any weight, to the effect that Mr. Lawes has no right to make any pretensions to science. I did not consider the position that the Messrs. Lawes and Way occupied in the scientific world; what I had to do was, to examine the report of Mr. Lawes, and having examined it, I was obliged to differ in opinion from him.

2423. Are you aware that it is the fact that Mr. Lawes received a testimonial from the great body of agriculturalists in England, to show the very high value that they placed upon his scientific services in investigations connected with agriculture?—I have heard that he received a testimonial, and I have also heard that he got the testimonial up himself, but I do not think that that has any bearing upon the report.

2424. Are you aware that Mr. Lawes holds a very high position as an agriculturalist in this country?—The question put to me had only reference to this report.

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2425. But you state that no man, with the least pretensions to science, would give any credit to those tables?—Yes, after examining them, that would be so.

2426. May I ask you what pretensions to science you have yourself to justify you in condemning such men as Mr. Lawes and Professor Way?—I make no pretensions to science; I have no intention of blowing my own trumpet. I test Mr. Lawes' results by the evidence that is before me and before the public, and that evidence clearly proves that those results are not such as should receive much credence from the country.

2427. At Question 1817, you speak of there being a limit to the profitable application of sewage; you state that that limit is very soon reached, and that if you pass that limit, you get no further benefit from the manure; have you yourself ever proved the limit to which sewage can be profitably applied?—If the Honourable Member will be good enough to read my answer to Question 1816, he will see that I based that opinion upon the evidence of Professor Way, and not upon my own results.

2428. You state that that limit is very soon reached; where does Professor Way say that it is very soon reached?—If the Committee will allow me, I will give it in the exact words of the witness, and not in my own, as it affects my own credit. At Question 940, in Professor Way's evidence before the Select Committee on the Sewage of Towns, in 1862, he was asked by Mr. Ayrton, "Can you apply the sewage with advantage to a low land, with a view to the growing a wheat crop afterwards?" His answer is, "I think you could do perfectly well in small quantities not to deluge the land. You could do it almost as well as you could apply it to the young wheat, I believe.—Do you think that it would have a sensible effect upon the produce of the land? Yes, from the fact that it is not the plant, but the soil which looks after the interests of the plant; the soil is engaged in abstracting from liquid manure the constituents which make it valuable.—Could you in that way, to any extent, get over the difficulty of applying the liquid sewage to the young plant, by applying a sufficient quantity of sewage to the land before it was planted? Yes, but you cannot go beyond a certain point in that way, or the power ceases." That is Professor Way's opinion.

2429. What power do you understand Professor Way to refer to there; is it not the power of absorption of the soil?—That refers to a previous question, which I will read; it is Question 776—"You have made experiments on the power of soils to absorb the manure contained in sewage? Yes.—Will you inform the Committee what were the results obtained by you? The results generally were these: that in soils there resides a power, which previously to my examination I believe was not recognised, to separate from liquids containing manure, containing ammonia for instance, and potash and phosphoric acid and magnesia, that is to say, all the important elements of manure, these elements; to separate them from water, not by mere filtration, because these things would pass through a filter, but by the peculiar chemical attraction possessed by the ingredients of a fertile soil for these liquids; so that, if we were passing a liquid containing manurial matters through a given quantity of soil, the water would pass through, and these matters would be retained and fixed in the soil. I look upon this as a great arrangement and provision of nature for the preservation of manuring principles from being washed out of the soil by rains." Then, at Question 918, Professor Way was asked, "You stated that in the application of sewage to land, very often not one-tenth of its value was taken out in the crop? I said, that it might be so, if put on in a large quantity; I said that with all manures, in certain crops, in order to get a given amount of crop, you must use very much more of the material than ever appears in the crop which you raise from it.—Comparing sewage with guano, would it be the same with regard to both those manures? Yes, in relation to their ingredients.—And much in the same proportion? I presume so.—You said that with guano, under certain circumstances, one-half of the virtue might remain, but that it would come out in a future crop; would that be the case with sewage? Certainly not, if the sewage had gone away.—Would there be more chance of the part which did not come out in the first crop being lost with sewage than with guano? If you put more sewage on to the land than the land can take up or abstract the value from, of course that is lost for ever, because it runs away."

2430. But, practically, you yourself have not observed the limit which you say is soon reached, and you cannot yourelf, from any practical knowledge of your own, state to the Committee what the limit per acre is, beyond which the soil cannot absorb the sewage?—I can tell you by the evidence of a number of witnesses.

2431. But not from any practical knowledge of your own?—I did not think it necessary to try any experiments when I had the evidence of Professor Way, Mr. Miles, of King's Weston, and Mr. Westwood, of the schools at Anerley. I thought that their experiments were quite conclusive, as they were disinterested people.

2432. You take 500 tons of sewage, do you not, as your average application per acre, under the system that you propose to adopt?—When I sent in my application to the Board of Works, in the early part of 1861, I then sent in also some calculations to show the reasons that had induced me to fix on a certain area, and I made a calculation, based on an average of 500 tons to the acre, but as 500 tons of the London sewage would contain about 8 cwt. of guano, worth 5 *l.* 5 *s.*, I think that that is too large a quantity of sewage to calculate upon disposing, at its fair value, over the area, since it will be used in addition to the manure made on the farms.

2433. Then you do not propose to apply so much as 500 tons an acre?—It is simply a question of price. For instance, if I give the sewage away, people can afford to apply it in enormous quantities, as they do at Edinburgh, or at Rugby, or at Croydon; but, if I charge for the manure according to the guano standard, of course they must put it on in moderation, or they would be ruined, just as they would be ruined at present if they applied guano or superphosphates in the same reckless manner.

2434. How do you propose to apply so small a quantity as something under 500 tons of sewage to the land?—I think that that is a large quantity, but that is an average; in some cases there would be more put on the land, and in other cases there would be less. To Italian ryegrass, for instance, you might give as much as 1,000 tons or 1,200 tons per acre.

2435. How many applications of the sewage would

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would you give in a year to Italian ryegrass?—I should apply it after each cutting.

2436. How often would you have cuttings?—I think we have it on record that there have been six or seven cuttings of Italian ryegrass, by the help of sewage.

2437. Did I rightly understand you to state that you proposed to charge the farmer 2 *d.* a ton for the quantity of sewage that he was to use?—I propose to charge exactly what the sewage is worth. Now, the sewage of London has been analysed, and I have here the report of Messrs. Hofmann & Witt, which clearly shows that the average sewage of the metropolis contains a certain amount of fertilising matter equal to guano, and that in 1,250 tons of this London sewage, there is an amount of fertilising matter which, if extracted and dried, would be equivalent to one ton of guano. The evidence taken by the Board of Health, and published in 1852 in their Report, and the evidence taken before the Select Committee of the House of Commons in 1862, clearly proves that the agricultural value of the manure contained in the sewage is greatly increased by being liquefied; and, therefore, I think that it is not unreasonable to expect that the farmers, if the sewage is delivered to them on their fields, free of all costs to them for carriage, will be prepared to pay for it a sum which is clearly beneath its real value.

2438. Five hundred tons, at 2 *d.* a ton, would amount to a little over 4 *l.* an acre; have you asked any farmer if he would take from you 500 tons an acre, at that price?—I have already said that I think it is too large a quantity to expect to sell at the price.

2439. What quantity would you expect to sell?—That is a thing that we must feel our way to. For instance, no one at the present moment can tell what effect will follow on any area where the farmers shall have the command of this valuable manure; I think, myself, that it will, to a great extent, revolutionise farming, and that quite a different system of culture will be adopted.

2440. Then you have yourself, from the knowledge which you at present possess, arrived at no accurate conclusion; is that so?—On the contrary, I have arrived at a very distinct conclusion, on evidence that cannot be shaken.

2441. Then what is the value that you place upon the sewage, in the quantity in which you propose to apply it?—There can be no question about the value; it has been analysed, and in each ton of the London sewage there has been shown to be fertilising matter to the value of 2 *d.* It does not require any judgment on my part.

2442. Have you asked any farmer whether he would give you that amount?—No, I thought it would be time enough to ask him when he had power to take it.

2443. From Question 1913 it would appear that you propose to lay down the mains merely to the farms, and to leave the farmers to conduct the water from the mains on to the fields; is that so?—My company propose, when it is formed, that we shall lay down works of distribution; that is, we will lay down the grand mains along the roads, and that the field pipes will then be laid down at the expense of the farmers or of the landlords.

2444. How much do you estimate may be the expense that the farmer will have to incur for laying down those sub-mains?—That is an expense that will, of course, depend upon the quantity of land over which he will lay them down, and the plan that he will adopt; if he chooses, of course he can lay down open carriers.

2445. But what will be the expense per acre?—He may adopt the plan of moveable pipes. I myself have not gone into any of those details, because I find them here very beautifully worked out in the Report of the Board of Health, published in 1852, at pages 138, 139, 140, 141, 142, 143, 144, 145, and 146.

2446. Can you state what it would cost the farmer or the landowner to lay down the sub-mains on his land per acre, receiving them from your mains?—Something under 4 *l.* an acre.

2447. You propose to extend your works over an area of 1,075,200 acres, do you not, over which you propose to apply the London sewage by your plan?—Not to apply it, but to lay down the works to enable me to reach a sufficient quantity of land.

2448. And, of course, you would also expect that if you laid down the works for 1,075,200 acres of land, the sewage could only be applied by the farmers laying down their sub-mains over that area, to enable them to make use of it?—No; I would lay down my works over that area, to bring me within reach of about 532,000 acres; and upon these acres, and not upon the larger area, the farmers would lay down their distributing pipes.

2449. Have you calculated what amount per acre, in addition to the cost of sub-mains, the farmer would incur in preparing his land for the reception of your sewage?—He would not be put to any additional expense in preparing it, if he applies it by hose and jet. If he applies it by open carriers, the expense would be very great indeed. I do not approve of the open gutters.

2450. Taking the hose and jet, can you state what that would cost?—Yes; at page 49 of this Report of the Board of Health, they say, "From this table it will be perceived that the cost of works and apparatus, on the average of all the examples examined of distribution by bed works and gutters, including the instance of the catch-water meadows, has been 31 *l.* 14 *s.* 7 *d.* per acre, and that the total annual charges and working expenses are 3 *l.* 7 *s.* 1 *d.*; that the cost of works and apparatus, on the average of all the examples of distribution by underground pipes, has been 3 *l.* 5 *s.* 1 *d.* per acre, and the total annual charges per acre, 8 *s.* 11½ *d.* per annum; that the total annual expenses of the cheapest example of distribution by open gutters, the Pusey catch-water meadows, was 14 *s.* 3 *d.* per acre; whilst the total annual expenses in the case of the cheapest example of distribution by underground pipes, and by jet and hose, was 7 *s.* 1½ *d.* per acre."

2451. But that is not an answer to the question which I put to you?—I think I have given an answer to both, because I have given the first cost and the annual expenses.

2452. Then what is the first cost to the farmer. In the first place, in the preparation of his land for the reception of your manure; and, in the second place, in the laying down of sub-mains for taking it from your mains?—As I have already stated, the farmer, if he applies it by the hose and jet, as I recommend, will not have to go to any expense for the laying down of the ground, but will have merely to lay down the pipes and hydrants, and that will come to about 3 *l.* 7 *s.* 1 *d.* per acre, and then the annual expenses, as I have already stated, are 8 *s.* 11½ *d.*

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2453. May we take it at 4 *l.* per acre?—It is under 4 *l.*

2454. £.4 per acre, applied to 532,000 acres of land, would be 2,000,000 *l.* more of fixed capital to be added to the whole capital which you propose as necessary to carry out your plan of applying the sewage; is not that so?—It will be under 4 *l.*; but I think that it is scarcely a fair way of putting it, unless you take what would be the returns.

2455. What would be the whole capital necessary to be expended in order to carry out the plan which you recommend the Metropolitan Board of Works to adopt; in your former examination, did you not state that the capital which you would require in order to bring the sewage on the ground would be between 3,000,000 *l.* and 4,000,000 *l.*; and that added to that there would be the farmer's or landowner's outlay in carrying that sewage over his fields, of nearly 2,000,000 *l.* more?—Yes.

2456. So that the whole capital necessary for carrying out your plan would amount to something like 6,000,000 *l.* sterling; is that the case?—That is not the outlay that the company will have to provide.

2457. But will it not be necessary to be provided by somebody before the sewage reaches the land?—Yes, before my plan could be carried out to its fullest extent, that expense would have to be gone to.

2458. In what district round London do you contemplate that you could obtain so large an area of land as you would require?—I do not propose obtaining such an area, because I propose to sell the sewage, and not to farm the land. The supposition that we can obtain, by purchase or lease, an area of sufficient extent, is an error; you cannot obtain an area of sufficient extent for that purpose so as to enable you to dispose of the sewage with profit to the ratepayers.

2459. Have you ascertained whether an area of 1,075,200 acres is available anywhere in the neighbourhood of London for the application of your system?—The land is there; all England, one may say, is there; and we have only to bring the sewage to the land and sell it.

2460. But it is a practical question which men of business have to entertain, as to whether the land could be got for the purpose. You seem to think, from your evidence, that it is an advantage to have a very large area of land?—If I had a very large quantity of manure to dispose of, whether it was sewage or guano, my practical experience teaches me that I must distribute it over a large area; it does not matter whether it is sewage, or guano, or superphosphate of lime, or what.

2461. Have you heard of a modern system of farming, which is to endeavour to get from a small area of land a very large increased amount of produce; are you aware that it is considered by modern farmers to be the most profitable system of farming rather to concentrate your capital on a small extent of land, and to endeavour to obtain from that small extent a large amount of produce?—Certainly; that applies to every business.

2462. If you found that you could get from 100 acres of land, with the same quantity of manure, as much produce as you could over 200 acres of land, could you not do it over the smaller area at a much greater profit to yourself than over the larger area?—Certainly, and I would much prefer it; but there is a limit to that; if I put on 100 acres of land such a quantity of guano or superphosphate of lime as I cannot get back in crop, I carry my system of concentration a great deal too far, and I ought to be put into a lunatic asylum.

2463. Have you had any practical experience of the application of sewage in a small quantity which can be set against the practical experience which we have on record of the application of sewage in large quantities?—I have the evidence of men whose characters are without reproach and beyond the reach of suspicion; I have the evidence of Mr. Miles, who is a man incapable of speaking what is untrue; that evidence has not been shaken, and I rest upon that; the Honourable Member cites against me practical experiments which are conducted by a man whose interest is manifestly opposed to the utilization of sewage upon my system. It is an outrage against common sense to say that the greatest manure manufacturer in the country, a man who clears 40,000 *l.* or 50,000 *l.* a year by the sale of artificial manures, should be permitted to carry on experiments at the expense of the nation to test the value of this rival manure.

2464. Are you aware that Mr. Marriage, who is the tenant of the Croydon works, and Mr. Johnson, who was examined before the Committee today, are manure manufacturers, or that they have any interest whatever in the sale of manure?—I listened to Mr. Johnson's evidence, and I contradict every word of it by the evidence which I have here; I listened to the questions which the Honourable Member himself put to Mr. Johnson, and the tenor of those questions was simply this: what is the largest quantity of manure that you can get rid of upon the land, and not what return can you get, in a commercial point of view, for that manure; of course it is a very profitable thing to Mr. Marriage, but it is a sad loss to the ratepayers of Croydon, for they do not get the value of their manure.

2465. Do you know any other instance in England of a thoroughly practical character where the application of sewage has been carried out with more care than at Croydon?—I do not see that they care at all about it; the manure of some 18,000 persons is allowed to pour over 250 acres. In the analysis of Mr. Hofmann and Mr. Witt, we are shown upon the evidence of Professor Way, Berzilius, Wesarg, and Liebig, that the excreta of the population is worth 10 *s.* 10 *d.* a head per annum; that is only the excreta, and in addition to the excreta there enters into the sewage of a town innumerable other matters of a fertilizing nature. Taking it at 10 *s.* 10 *d.* a head, the excreta from 18,000 persons being put upon 250 acres of land, we see at once that there is an enormous loss of manure, because the produce, no matter what it amounts to, cannot possibly pay for that manure; over 10,000 *l.* worth of manure is put over 250 acres of land, and we are told that is a great success; I say that it is a shame to Croydon that it is done.

2466. Did not Mr. Johnson state that the application of the sewage might with advantage be extended to 300 acres?—He did.

2467. Did he not state that the value of the crop was about 30 *l.* an acre?—Take it so.

2468. Does not that amount to nearly 10,000 *l.*?—Nine thousand pounds; but that is excreta alone.

2469. Does not that practically produce very

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much the same amount of money that you estimate its value at?—No, it does not.

2470. If 300 acres of land produce 30 *l.* an acre, and that amounts to 9,000 *l.* a year, is not that very much the same amount that you yourself say that chemists have found to be the real value of the excreta of the population?—I have already stated that in addition to the excreta, there enter the sewers of a town innumerable other matters of a fertilising nature.

2471. Have you not just stated that it ought to realise 9,000 *l.* or 10,000 *l.*?—The excreta alone ought to realise that, but there are innumerable other matters in the sewage of a town which are of equal value with the excreta.

2472. Are you not surprised to find that the gross amount realised is so very near the chemists' value of the excreta of the inhabitants?—No, I would require further evidence upon all those points; but all this argument applies to guano as well as to the sewage. If it would pay to use this sewage in large quantities on the land, why do not farmers use guano or superphosphate of lime in the same way?

2473. Do you think that guano or superphosphate of lime, if applied to corn in large quantities, would pay?—No.

2474. Do you not know that there is a large distinction between corn and grass cut green?—If the Honourable Member will refer to the evidence of Lord Essex, he will see that when Lord Essex applied sewage in moderation, at the rate of about 250 tons to the acre, his Lordship had a very large profit on his corn crop. I think that that was a sensible application; but, of course, if you put a very large quantity on, you injure the crop and you lose the manure.

2475. Does that apply also to grass?—At Question 21 of his evidence his Lordship is asked this: "From certain reports which we have, I find that on the Exe Moors the application of liquid manure by Mr. King had the effect of destroying moss, heather, gorse, and weeds, producing instead sweet and luxuriant grass?" And his answer is, "Yes, most decidedly. In the preparation of the grass which I cut for hay I put on about 600 tons per acre, and it has destroyed fern, and a quantity of plantain and coarse weeds of that sort, which have been replaced by valuable grasses: that I can speak to most decidedly; it has improved the herbage, both in quantity and in quality, in an infinite degree." That is 600 tons to the acre.

2476. I speak entirely from memory of what happened two years ago; but does not Lord Essex say, in his evidence that he took a much larger extent of ground for the application of the sewerage that he had at his command than he found afterwards he could profitably apply it to?—I take Lord Essex's results, and I take Lord Essex's opinion; and I have a right to form my own opinion upon his results as well as his Lordship; his Lordship may make mistakes as well as anybody else. He laid down piping over a larger quantity of land than he afterwards applied the sewage to; and the reason for that was that he applied the sewage at the rate of 5,000 tons or 6,000 tons per acre per annum. But I can prove, from the evidence of his Lordship, that he lost a very large quantity of that sewage when he did apply it in those large quantities.

2477. But according to Lord Essex's own evidence, so far as I remember it, he stated that he expected that he could apply usefully to his grass lands a much smaller quantity of sewage than he found afterwards he really could practically carry out?—I think he did not state so.

2478. Did he not state that he had laid down his works for the application of the sewage which he had at his command, over a much larger area than he found, in practice, it was profitable to apply it to?—That was the substance of his evidence; but we have the results obtained.

2479. With regard to the tanks of 12 acres in extent, and 15·5 feet deep, where do you expect to get a piece of ground suitable for the construction of such a tank?—In my evidence on the last day of the meeting of the Committee, I stated that it would be necessary for me to survey the entire area before I could fix upon any spot.

2480. Then you have not surveyed the area yet?—Certainly not.

2481. And you have not fixed upon any precise locality yet, where this large and important work is to be placed?—No, I have stated to the Board of Works that they shall have a veto on all spots that they disapprove of, and that this summit reservoir is not to be constructed in any place that they object to.

2482. How many hundred feet do you propose the elevation of these reservoirs to be?—That also it is impossible to state until I get the levels; of course the lower they are the better it is; but in my evidence, assuming everything against myself, I calculated that it would be necessary to pump to the top of Shooter's Hill and Hampstead Heath, merely taking those two places as the highest points.

2483. You propose that the wall inclosing those tanks should be a foot and a half thick, do you not?—That is merely a rough estimate.

2484. Have you made any calculation of the pressure of such an enormous body of water?—You will permit me to observe that the honourable Member for Coventry referred to that on the last occasion of my being examined; he asked me whether I thought, after the accident that had occurred at Sheffield, any reservoir would be allowed to be put up any where near London; I stated that there was nothing in common between the two, because the reservoir at Sheffield was constructed by throwing a dam across the entrance to a valley, but that in my case a hole would be merely scooped out on the top of a hill, and in that hole my reservoir would be constructed, and, therefore, the pressure would be supported by the surrounding earth.

2485. Then you must get a hill with a top sufficiently extensive to admit of that tank of 12 acres being placed upon it?—It must be either on the top or the side of the hill; it does not follow that it must be on the top.

2486. But if you take the side of a hill, will not a very deep cutting be necessary?—No.

2487. Do you propose to cover those reservoirs?—Yes.

2488. In what way would you cover them?—By arching over.

2489. Over the whole 12 acres?—Certainly, to prevent any nuisance; not that I think there would be any nuisance if they were open, but to prevent all fear of nuisance.

2490. At Question 1932 you are asked, "Supposing the landowners or the farmers did not choose to have this sewage, what would you do"? your answer is, "In that case the thing would be a bad speculation; but we know that at present there

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there is a great want of manure, and I think I am right in assuming that if we bring manure within reach of the farmers they will purchase it at a reasonable price." Have you looked at the evidence that was taken on that point by the previous Committee?—I have studied it.

2491. Can you refer me to any part of that evidence where a farmer said that he was quite willing to pay a price for the sewage?—Yes, I think that we might refer to Mr. Tregelles's evidence; I think he gave something of that sort of evidence if my recollection serves me, and I believe, too, that Mr. Westwood ran out some calculation for the Committee which showed that it was a very profitable thing.

2492. Mr. Westwood was not a farmer, but the manager of some schools, and his experience as given to the Committee was as the manager of an establishment at Anerley for children, where the sewage was in a very concentrated form indeed?—On the contrary, his evidence went to show, if I mistake not, that the sewage there was more diluted than that of London, inasmuch as there was a very large supply of water and nothing but the excreta of the inhabitants. Although he was connected with a poor school, his duties did not lie in any way in connexion with the pupils, but he was the farm bailiff, and I believe a scientific agriculturist.

2493. Can you refer me to the evidence of any rent-paying farmer who said that he would be quite willing to pay a certain sum for sewage?—Yes, Mr. Mechi.

2494. But is he a rent-paying farmer?—He tells us so.

2495. Has Mr. Mechi ever used town sewage?—No, because he has not the means of getting it. I produced a letter from Mr. Mechi, at the last meeting of the Committee, in which he stated that his sewage was about one-third of the strength of the London sewage.

2496. In answer to Question 1960, speaking of Messrs. Napier & Hope, you say: "They were running all through London, trying to get the money; and they could not get the money, and did not get the money." Have you any proof of that?—A gentleman came to me at the time, and told me that they were offering a large commission for it.

2497. You do not state that as an absolute fact, within your own knowledge?—I had it in that way at the time.

2498. You state, in answer to Question 2001, that you were the first person almost who has put the matter in a definite way before the country. How long is it since you first turned your attention to the utilization of sewage?—My attention has been turned to the utilization of sewage for 10 or 14 years; but what I meant to express by that was, that I believe I was the first person who drew attention to the difference between large and small dressings on land.

2499. Are you not aware that at a much earlier period than 10 or 12 years ago, Mr. Pusey, the late Prince Consort, and many other eminent persons connected with agriculture, had made sewage a study with regard to its application to land?—If the honourable Member had permitted me to conclude my answer, I was just going to make that observation.

2500. Are you yourself a practical farmer?—I consider that I am.

2501. Where have you farmed land?—In Ireland.

2502. Have you ever farmed on your own account, as a rent-paying farmer?—As I stated in my examination on the last day of the meeting of the Committee, I have never held land myself, but I have managed my father's farm; it has been left under my management, and I was specially educated with regard to agriculture.

2503. On this farm, under your own management, have you been in the habit of using liquid manure on the soil?—No.

2504. Have you any practical knowledge, from your experience, either of the mode of its application, or of the results which would arise from that application?—From my own experience, as I have already stated, I have not; I base my opinion entirely upon results obtained by other parties.

2505. Are you an engineer?—I know something about engineering, but I do not call myself an engineer.

2506. Are you a chemist?—No; I am an Irish solicitor and land agent. If the Committee will permit me I will read a letter which I have received from a Master in Chancery in Ireland, with reference to a statement that I had been struck off the Rolls. This Letter is from Mr. Litton, who formerly and for many years represented Coleraine in this House, and has been for many years a Master in Chancery in Ireland:—"Master in Chancery Chambers, Four Courts, Dublin, 30th May 1864. My dear Ellis,—Your letter of the 28th instant, did not reach me till yesterday. I hasten to reply to it. You inform me by it, that in some communication made in reference to you, some one has put in writing the following expression, 'I find I have one or two opponents, &c., the one, a person named Ellis; I beg to inform you this man is an Irish solicitor, struck off the Rolls for a cause,'—I hereby certify that it is an infamous falsehood that you were ever struck off the Rolls of Irish solicitors. You practised (for some little time) with credit and with honour, and then seceded voluntarily from the Profession, to pursue avocations more congenial to your tastes. In my life I never heard one word uttered which could derogate from the character for honour and truth which you have always borne. I am, my dear Ellis, faithfully yours, Edward Litton."

2507. Have you changed your mind at all in the course of your consideration of this question, and of the offers which you have made to the Board of Works, as to the value of the sewage, the mode of its application, and the cost of your system?—Not the slightest.

2508. In answer to Question 1790, in quoting from your own book, you speak of certain quantities of sewage which should be applied to grass land, and you say in your evidence that you have since ascertained that that statement which you originally made is a mistake; so that you have since changed your mind upon that point, have you not?—I understood the Honourable Member to ask me whether I had changed my mind with reference to the mode of application; that is, with reference to the hose and jet.

2509. Then your first proposal is different in that respect from your second proposal?—No; my first proposal is reprinted now with my tender, and in it I base my calculation upon an average of 500 tons; I think that that is too large an average quantity to expect to sell with profit.

2510. You have again changed your opinion in that respect, and you would further lower the quantity

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quantity of sewage to be applied to the land?—No; as I stated in my direct examination, when I wrote that in 1860 I did not know so much about the sewage as I now do; I now, with my increased knowledge of that question, think that 500 tons is too large an average to dispose of with an advantage; it is simply a question of price.

2511. At Question 1811 you seem to have it in view hereafter to mix with the sewage some other manure, and apply the two together to the land; but while you seem to have that in view, you have not, evidently from your answer, come to any conclusion as to how it should be done, or as to what should be done?—My calculations are entirely based on the sewage as we find it in the sewers. That question originated with the noble Chairman referring to a letter of Baron Liebig's, which has appeared in all the papers, in which he states that the sewage may be increased and improved in value by adding different matters to it; and I think there is no question that he is quite right.

2512. With regard to the horse power upon which your first estimate was formed, you state that you have since discovered that that estimate was greatly in excess of the real amount?—Yes, I was aware of at the time, and stated it in my letter, and the reason of its being in excess is this, because I made my calculations to pump to an elevation, on the north side, of 460 feet, and on the south side, of 430 feet; and I am perfectly certain that it will not be necessary to pump to such an elevation on either side; and, therefore, I say that my horse power is calculated in excess of the necessary amount.

2513. But without reference to the height, is not the expense of the horse power a question which can be answered precisely?—With the greatest accuracy.

2514. It is stated by you at 40 *l.* per horse power, and that that is greatly in excess; is that so?—That is the price of erecting engines.

2515. Then you do not consider the price of 40 *l.* per horse power extravagant?—Yes; that is in excess; and I will explain why it is in excess. That price is for the gross horse power; now the scientific witnesses who have been examined to-day, stated that about 55 *l.* would be a fair price for the net horse power, but if that calculation is run out to the gross horse power, it will be found that the 40 *l.* is too high a figure; and I think that if any of those gentlemen who have been examined to-day are here, they will bear me out in that.

2516. With regard to the reservoir, what do you suppose would be the effect upon the springs of water in the neighbourhood from a leakage in your reservoir?—I do not suppose that there would be any leakage; it would be a very faulty reservoir if there was.

2517. *Chairman.*] You offered a fluctuating rent to the Board of Works of one-half of the profits, did you not?—Half the net profits, after paying the working expenses.

2518. Assuming that you could sell all the sewage, and recover the value that you have estimated it at, what would your profits be per annum?—After making very large deductions for the working expenses, the net profits would amount to 1,884,979 *l.*, or over 30 per cent. on the outlay of the large sum of 6,200,787 *l.*

2519. Then you expect to be able to give the ratepayers 900,000 *l.* a year, according to that?—Yes.

2520. What proportion would that bear to the local taxation of the metropolis?—I have endeavoured to ascertain that, and, as nearly as I can make it out, the local taxation of the metropolis amounts to about 3,000,000 *l.* per annum; therefore, what I propose would come to about one-third of that.

2521. If the Board of Works agreed to a fluctuating rent, would not that involve the ratepayers in a certain liability of partnership?—I do not see that it would; no liability could ever be incurred until we got our Act of Parliament, and of course in that Act the ratepayers could be fully protected from any liability. I propose also to the Board of Works, that I shall not proceed to obtain my Act of Parliament until they approve of all the clauses that are to be inserted in that Act.

2522. Do you object to a fixed rent?—I do, because I think that it would be unjust to the ratepayers in a variety of ways. If such a rent is demanded as would be fair to them (and I think they are entitled to half the profits), it would be impossible for me to raise the capital. If I offered them a small rent, there would be no difficulty, but then that would be unjust to the ratepayers.

2523. Were not you asked by the Board of Works to agree to a fixed rental of 10,000 *l.* a year?—No, I was not; the sum was not mentioned; it was thrown out as a suggestion at that celebrated interview, whether I could not offer a fixed rent, and I certainly objected to it; but there would be no difficulty whatever in paying a fixed rent of 10,000 *l.* a year. We could easily invest in the funds a sufficient sum of money to pay a rent of 10,000 *l.* a year; and then selling the sewage at 2 *d.* a ton, and making all sorts of allowances for working expenses and bad debts, we should have a net annual revenue of 1,800,429 *l.*, or 45 per cent. We should make a very splendid thing of it, but it would be defrauding the ratepayers.

2524. Are you not aware that the chairman of the Metropolitan Board of Works is decidedly in favour of a fixed rent, as shown by his evidence before this Committee?—I understood that he expressed himself to that effect in his examination.

2525. Do you not think that he is likely to express the wishes of the ratepayers on that point?—He is not in accord with the wishes of the ratepayers, as shown by the resolutions which have been passed by public meetings in favour of my plan, and in favour of a fluctuating rent, and decidedly objecting to a fixed rent.

2526. Did not the Messrs. Napier and Hope offer a fluctuating rent of half the profits, after deducting a dividend of 10 per cent.?—Yes; that was in 1861.

2527. Mr. Thwaites was in favour of that scheme, was he not?—I gather so from the fact that I find his name to the Report of the Main Drainage Committee, which is favourable to that scheme.

2528. But if he objects now, must he not have seen some cause for changing his mind?—I presume there is some cause, but it is difficult to say what it was.

2529. Are you quite firm in your opinion that a fluctuating rent would be the fairest for the ratepayers?—I think there is no question about it; in fact, it would be an utter impossibility to raise

raise the capital if such a rent is demanded as would be fair to the ratepayers.

2530. You stated, in answer to a question put to you by the Honourable Member for Stirling, that you objected to any company using the sewage on any land in their own possession; why do you object to that?—I object to any company using the sewage on lands in their own possession, for a variety of reasons. I think that it would be impossible for any company to raise the capital for the works, and for the purchase of an estate of sufficient size, so as to utilize the sewage of our cities to the best advantage of the ratepayers; and I think also that it is scarcely fair to agriculture that any company should have a monopoly of the use of these large supplies of manure exclusively for their own estates. I think that that manure should be thrown open to farmers, and then it would benefit the landed interest generally.

2531. Then what you intend amounts to this, that your company should be merely carriers of the sewage?—Carriers and retailers.

2532. Do not you contemplate any difficulty in getting rid, day by day, of the daily flow of the sewage of London?—Not the slightest. I have run out some calculations about that which will show how very simple it is. The total available sewage of the metropolis amounts at present to about 266,052,440 tons per annum, and the area for its distribution will be about 532,104 acres, forming part of a larger area of 1,680 square miles, equal to 1,075,200 acres, over which the works of distribution will be laid down. The daily flow of the sewage will be about 728,911 tons, equal to 25,656,840 cubic feet. This will be put on the land during the 10 working-hours of the day. But, assuming that it could all be delivered at once on the land, there would be 1·37 tons for each acre, equal to a depth of the one-thousandth part of a foot. And assuming that over 4,859 acres, or the one-hundred-and-ninth part of the area of 532,104 acres, an average of 150 tons per acre per day was applied, the entire day's supply of sewage would be exhausted, leaving nothing for the remaining 527,245 acres of the area. From these figures, it will be seen how easily the daily flow of the London sewage can be disposed of in an economic manner. But inasmuch as the proposed area of 532,104 acres is based on the assumption that an average of 500 tons of sewage, in addition to the farmyard manure, would be taken, it is clear that this area must be extended, because we can scarcely expect that so great an average as 500 tons of sewage would be taken and paid for according to its value, tested by the guano standard, as in 500 tons of sewage there are 8 cwt. of guano, which, at the present price (13 *l.* 2 *s.* 6 *d.* per ton), would be worth 5 *l.* 5 *s.*

2533. All you desire is to make a conditional arrangement with the Metropolitan Board of Works, in order to justify you in undertaking the expense of making surveys and plans; is that so?—That is all.

2534. Do you intend to defray the expense of those surveys and plans out of your own pocket?—Entirely. What I propose is, that I should take this question before Parliament at the risk of myself and my friends, and that we should pay all the expenses attendant on getting our Act of Parliament. Those expenses would be very heavy. In the first place, we shall have to survey 1,680 square miles of country.

2535. You do not intend to ask for any money from the public until your Bill has passed a Private Bill Committee of the House of Commons; is that so?—We shall ask for none whatever until then.

2536. Mr. *Tite.*] In your examination by the Honourable Member for Chatham, on the last day of the meeting of the Committee, reference was made to a particular failure with regard to the works erected by the Duke of Northumberland, and you were asked this question: "Those works were erected by the Duke of Northumberland, and then the inhabitants and occupiers of the land in the district refused to pay for the pumping; how do you account for that?" and your answer was, "I do not know what the strength of the sewage was, and whether it was good or not; and I do not know whether the sewage might not have been poisoned before it reached the land." Are you in earnest in such a suggestion as that, that you could poison the sewage?—Certainly, it could be poisonsd by introducing chemicals into it before it reaches the land; solutions of iron, for instance, would have the effect of rendering it actually injurious to the land.

2537. But who would do that?—It is not for me to say who would do it.

2538. Do you imagine that the Duke of Northumberland's agents who permit the sewage of a town, or of a district, to be poisoned: and if so, by whom is it to be done, and for what purpose?—Of course the Duke of Northumberland would not permit it if he knew it; but there is nothing to prevent any person having premises connected as they must be with the sewers, from allowing injurious matters to run into the sewers from their premises, without the knowledge of any other party.

2539. To what extent, and for what purpose could anybody do that?—There might be a great object in showing a failure of the sewage, and in thus preventing the sewage from being utilized.

2540. But who is to show the failure?—Those who have an interest in it.

2541. But is not the interest the other way?—Certainly not; the public generally would desire to see the sewage utilized, but there are classes in England who would be injured by the utilization of the sewage, because it would reduce the amount of artificial manure sold, and would also reduce its price.

2542. But is not England large enough to take all the manure that they can supply?—If you calculate the value of the sewage of our cities, and if it is to be utilized over a large area, you will find that it will displace a large amount of artificial manure, and consequently reduce the amount of that artificial manure which is sold, and also reduce its price.

2543. Then do you mean that those people who sell artificial manure would gravely set about poisoning the sewage on the land of the Duke of Northumberland, for the purpose of preventing the use of that sewage as manure?—No; I say that it is possible, and that it can be done.

2544. But you ought to follow it up with the probability of such a thing being done?—I am not bound to do that; if you consult any chemist you will find that, what I state is perfectly correct.

2545. That is not the question, as we know, arsenic would poison the sewage; you suggested that

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that the sewage might have been poisoned, and that, therefore, the experiment might fail, but who is to poison the sewage, and how is it to be done?—I do not know what are the facts of the case there.

2546. Are they not stated distinctly?—No, they are not stated; the case is merely mentioned.

2547. I repeat the question as it was put to you, "Would you be astonished to hear that a large proprietor has erected works at very great cost, to be used in a certain district, and that all that he required was, that the occupiers of the ground should pay for the pumping, and that, after two or three years' experience, they declined to pay for the pumping"? and your answer is, "I should be astonished if no explanation were offered." The next question is, "Those works were erected by the Duke of Northumberland, and then the inhabitants and occupiers of the land in the district refused to pay for the pumping. How do you account for that"? Your suggestion in answer to that question is, that the sewage might have been poisoned. Can you condescend upon the exact feeling, in your mind, when you stated that it might be poisoned?—Allow me to read the answer, "I do not know what the strength of the sewage was, and whether it was good or not, and I do not know whether the sewage might not have been poisoned before it reached the land; I could poison any sewage. The Duke of Northumberland holds a very high position as an agriculturist, and if he threw the weight of his name and influence into this question, it would be solved at once, and it would therefore pay the artificial manure men."

2548. But can you state whether I am right or not in supposing that anybody would be wicked enough to set about poisoning the sewage which the Duke of Northumberland cast on to his land?—There are a great many wicked people in the world, and a great many people who have large interests.

2549. The question which was put to you suggested that the farmers were so discontented about the sewage, that after his Grace had gone to an immense expense in putting pipes on the land, they refused to pay for the pumping; does not that show that it would not be of any use to put the sewage on the land which you propose to deal with?—But here I bring the evidence of Mr. Miles, who has applied sewage to land for years, most successfully; Mr. Miles applied the sewage of 30 persons over 14 acres, or the sewage of two persons per acre at King's Weston, and there he has obtained such an immense profit as would clearly prove the case for me.

2550. After you have spent your 6,000,000 *l.* of capital, it all turns upon the question whether the farmers will go to the expense of paying you for the sewage. Here is a case where, having tried it for two years, they declined to pay the expense of pumping; the two things may be reconcilable, but can you explain them?—I am merely asking for permission to take this matter before Parliament, after I have had time for bringing up proper evidence on all these points; of course I must prove a variety of things that are now in doubt—and I am quite prepared to go to all that expense; if I am wrong in what I assert as to the value of the sewage, and its application, then I shall be a heavy loser; but if I am right, and I think I can produce proof on that point, then I shall be rendering a great service to the country, and why should I be refused permission to test the matter?

2551. But the Board of Works may not be so sanguine about it as you yourself are; and, seeing that there are four or five schemes of great respectability before them, it is quite reasonable for the Board of Works to be very careful, and not to shut themselves up to the scheme of one man in preference to another without strict investigation. You state that it is not reasonable for the ratepayers that you should undertake to give a certain amount annually in competition with anybody else; but that is the concern of the Board of Works, and not your concern?—Pardon me, my character is at stake.

2552. You state that you are not entitled by your ingenuity to make the large profit that you suggest: there is no impropriety in that; you are doing no injustice?—Certainly; I am doing an injustice to the ratepayers in depriving them of their property on any pretext whatever.

2553. You are asked on your *bona fides* to pay a certain amount of money annually?—I make a very bold offer; when I say that I am prepared to risk 60,000 *l.* for testing a question, that, I think, is a very fair offer to make.

2554. You are asked to make an offer of money, as a test of your *bona fides*, and as a means of coming to some result, so as to guide the Board of Works in their decision; because, if your speculation is a failure, they will have lost their time, and you will have lost your money. First, you ask that a concession should be given to you, and then you say that a large sum of money should be expended by you in preparing to go for an Act of Parliament; would that include also the deposit on six millions of money?—The 60,000 *l.* would not include it, of course. We do not know what the estimated amount would be yet, but we expect that it would be about 4,000,000 *l.*

2555. Would not that be 160,0000 *l.*, at 4 per cent., upon that kind of works?—Yes.

25556. Then, supposing that you had got a Bill in Parliament, you have all the capital to lay out before you get a farthing in return?—No; pardon me; as soon as the summit reservoir was constructed and the engines erected, then, as we laid down our mains over the area, we could commence distributing the sewage.

2557. Then, to a certain extent you would be getting a return?—To a certain extent we should.

2558. Have you inquired of the farmers whether they will take your manure?—No, that will be necessary when we come before Parliament for our Act.

2559. With regard to the Metropolitan Board of Works, have you ever had any discourtesy or incivility from the Chairman of the Board, or from any member of the Board, or from any officer of the Board?—I have very seldom come in contact with them.

2560. But when you have come in contact with them, have you experienced any discourtesy or incivility?—No; but I think that this proof of my evidence is a very great discourtesy.

2561. What evidence is that?—That is the evidence which was sent to me for correction, headed in this way: "Private and confidential; printed for the use of the Members of the Board only. Proof for correction of verbal inaccuracies only, without adding to or diminishing from the answers given." I will read one instance,

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stance, which occurs at page 7: "The Chairman. You propose to take the sewage from certain points?—Mr. Ellis. I purpose to take it from the points mentioned, and to pass it through covered aqueducts into wells. I asked permission of the Board to make use of their engine power, which would enable me to make the reservoir smaller." Now, where will any such application be found? On the contrary, I have never done anything of the kind.

2562. Do you not think that probably the shorthand writer made a mistake, and that you were misunderstood?—No; that is a thing that no mistake could occur in; it is impossible that such a long sentence as that could have been put into my mouth by a mere error of the reporter; that is a deliberate alteration of my evidence, and the object of that is this: Messrs. Napier & Hope, and Lord Torrington, asked for the engine-power of the Board, and it is to beat me down to a level with them that that is introduced.

2563. But why could not you correct that?—It is only one item in a long train; for instance, in the Report of the Main Drainage Committee, of the Metropolitan Board of Works, on the tenders, dated the 29th of July 1863, I will give an illustration of the manner in which I have been treated by the Board. It is stated in the report that "Mr. Ellis proposes to pump the sewage from the Board's reservoirs, to certain covered tanks constructed at such points as the Board may approve on the banks of the Thames, from which it will be allowed to flow by gravitation." Now, how sewage could flow by gravitation from reservoirs constructedon the banks of the Thames, I am quite at a loss to say.

2564. Is there any doubt about the passage which you have read being in that Report?—It was so originally, and I caused it to be altered; I applied to the Board, and I pointed out to Mr. Thwaites the impropriety of its being set out in this Report that I proposed to pump the sewage to reservoirs in the lowest situations in the level.

2565. Was that mistake corrected?—It was corrected here, but whether it is correct in the papers sent to the Committee, I do not know.

2566. *Chairman.*] It is here "on the banks of the Thames"?—Then they have restored the error, so that that is a false return made to Parliament. That is just in keeping with every act of the Metropolitan Board of Works towards me.

2567. Mr. *Tite.*] Was that document published or printed, or sent to you for correction?—It was published by the Board and sent to me; that was the original mistake, which was corrected at my request, and now it is gone back to.

2568. But was the Report reprinted, or was your correction inserted in any print?—It was printed; I happened to be at the Board of Works when this Report was agreed to, and I saw the proof and observed the error; I applied to Mr. Thwaites to have the error corrected, and it was corrected, and now the original error is reinstated in the papers which are before this Committee.

2569. Mr. *Ferrand.*] You propose to supply the farmers by underground pipes, do you not?—I propose that the mains of the company shall be laid underground along the roads, and that the farmers shall then lay down pipes under such fields as they choose to apply the sewage to, and on those pipes hydrants will be erected; they can either apply the sewage by a flexible hose and jet screwed on to those hydrants, or they can allow the sewage to escape in open carriers, and then to flow on to the ground.

2570. Did you not state that the expense of supplying the farmers with the sewage by underground pipes would amount to 4 *l.* an acre?—To something under 4 *l.* an acre.

2571. In your opinion, could not the farmers in the country receive the whole of the sewage on their land in open drains?—They could receive it in open carriers when I brought it to them, but it would be a wasteful method of applying it.

2572. Is there nothing to prevent their doing that?—Nothing whatever.

2573. Could not those open drains be made by the plough?—They could, but there would be then a great escape of the sewage into the bottom of the soft furrow that would be formed by the plough. If drains of that sort were made, it would be better that they should be tiled at the bottom, so as to prevent any escape.

2574. Then could they be made on the surface?—They could.

2575. What do you consider is the value of crops of grass during the whole year per acre from land highly tilled with sewage?—A paper was sent in to the Select Committee in 1862, from Mr. Tufnel, and he stated that as much as 100 tons of Italian rye grass per acre had been raised at the schools at Anerley in a year by means of repeated cuttings of Italian rye grass, and Mr. Lawes gets about 32 tons of common grass at Rugby.

2576. What would be the value of that per ton?—That would depend upon circumstances. Upon the land at Edinburgh, it is purchased by the cowkeepers, and I believe they pay as much as from 30 *l.* to 40 *l.* per acre per annum for the grass.

2577. Have you any idea what would be the value of it to a farmer in the country?—I think that the value would be as much to him if he did not grow more than he could consume with his own cattle as to any body else.

2578. You cannot form an exact opinion upon that point?—No.

2579. Can you give the Committee any opinion as to what would be the difference in value between an acre of grass produced by a highly tilled system of sewage and that produced by farm-yard manure?—There were some answers given in the last Committee, by Mr. George Foster, in reference to the farming at Kingsweston, and he shows the value of the different crops raised; but he does not contrast them with the result that could be obtained by farm-yard manure; I may mentiom that Mr. Lawes, in his evidence, stated that he never was able, with the most enormous quantities of solid manure, to obtain more than about 12 tons of grass to the acre; but as he shows in his tables, he obtains over 32 tons to the acre, by sewage.

2580. Then do you consider that Lord Essex over-dosed his land with sewage?—A portion of it; I think he applied too much to his Italian rye grass; and one of his answers proves that he lost a very large quantity of it; for he speaks of having grown a crop of wheat after a crop of Italian rye grass, and he says that, for a long period, it was so bad and wretched looking that he was inclined to plough it up; but that in the spring, all on a sudden, it took the most extraordinary growth that he had ever seen, and that he attributed that to the roots having got far down into the soil, where a quantity of liquid manure had

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had accumulated, which had been applied to the Italian rye grass. That shows that there was some loss of sewage on the Italian rye grass, but we do not know what was the extent of that loss.

2581. You have had questions put to you as to the mode of construction of your reservoirs; is it not the fact that to scoop out a reservoir is considered the only safe way of making one?—I believe there can be no question among engineers that it is the safest way.

2582. You have alluded to an accident which occurred at Sheffield, and which was caused by the bursting of an embankment made across a valley. The reservoirs that you intend to make are to be made on a level, by scooping out, are they not?—Yes.

2583. Are you aware that news has arrived lately of the seizure by Spain of the Peruvian Guano Islands?—I have heard of it.

2584. Do you not consider that it would be wisdom for England to make herself as independent as possible of foreign supplies of manure?—Baron Liebig has drawn attention to that, and has shown how completely the agriculture of England is at the mercy of foreign nations for its supplies of manure.

2585. The Peruvian Government have laid a heavy export duty on guano for some time, have they not?—They make, I believe, 6 *l.* a ton out of it.

2586. Do you know where the sewage which was applied on the Duke of Northumberland's land came from?—From the town of Alnwick.

2587. Do you know of any chemical manufactures there?—I do not know as to that. At Edinburgh they put on considerably more than 100 *l.* worth of sewage to the acre, and they only get 30 *l.* worth of grass. That is a great failure.

2588. It is not uncommon, is it, for the refuse of chemical manufactures to be conveyed secretly underground, in towns and villages?—It is invariably done; but evidence was taken as to that before the Select Committee, in 1862; and it was the opinion of the chemists who were examined before that Committee, that as far as London was concerned, the vast amount of the sewage of London would defy any injury of that sort.

2589. Supposing that there were any chemical works at Alnwick, and that the refuse was conveyed by those secret drains from those chemical works, and that it was supposed by the farmers that that was injuring their land, are you aware that there are any powers by Act of Parliament to enable people to enter those works to examine whether that refuse was so conveyed?—I am not aware of any such power; but I think that we should have that power, unquestionably.

2590. Are you aware whether the sewage which the Duke of Northumberland's tenants use has been tested?—I am not aware of it.

2591. Mr. *Hibbert.*] With regard to the elevation, to what height do you propose to pump the sewage on each side of the river?—I cannot possibly say until the levels of the area are taken; we must pump it to a sufficient height to dominate over the whole area.

2592. Should you pump it to a height of 300 feet?—I have consulted Mr. Hughes upon that, and he is of opinion that a height of 300 feet would be sufficient.

2593. It has been stated that there might be a difficulty in the sewage being conveyed by gravitation along your mains, owing to the difficulty of delivering it at a considerable distance from your reservoirs; do you anticipate any difficulty from that?—Not the slightest, because it would be entirely overcome by the head of sewage, assuming, of course, that we pump to a sufficient elevation.

2594. (To Mr. *Bowing.*) Would it not be possible, in case you found a difficulty from the friction, to pump at different places, and not to do the whole of the pumping at one place?—The number of lifts would be quite immaterial to the distribution. The head would be the same whether it was lifted in one or two lifts.

2595. But suppose that instead of lifting the whole 300 feet at a place, A, you lifted 200 feet there, and then at some place, five or six miles from London, you lifted another 100 feet, would you not then get over the difficulty of friction?—Clearly; but then it would be two distinct systems instead of two lifts.

2596. But owing to the sewage having to be delivered at a much shorter distance from your reservoir, would you not then get rid of the difficulty of friction?—Clearly.

2597. Sir *Joseph Paxton.*] What is contained in that bottle which is before you on the table?—That is sewage as it escapes from the sewer.

2598. Have you any evidence to give with regard to that?—It is merely to show to the Committee, because there is an idea that sewage is something much more solid than this; I wish merely to show that there would be no difficulty about the pumping.

2599. You do not mean to state that that is all the difficulty which you would have to deal with in pumping?—Yes.

Lunæ, 6° *die Junii*, 1864.

MEMBERS PRESENT:

Mr. Adderley.	Mr. Leader.
Dr. Brady.	Lord Robert Montagu.
Mr. Caird.	Sir William Russell.
Mr. Hibbert.	Mr. Tite.

LORD ROBERT MONTAGU, IN THE CHAIR.

JOHN FREDERIC BATEMAN, Esq., called in; and Examined.

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2600. *Chairman.*] YOU are a civil engineer, are you not?—I am.

2601. Have you had great experience in the construction of waterworks?—Yes, I have; I have constructed waterworks, great and small, for the supply of about 2,000,000 people.

2602. You designed and carried out the works for supplying Manchester and Glasgow with water, did you not?—Yes; those are the two largest works that I have constructed.

2603. Is not Glasgow supplied with water from Loch Katrine?—Yes.

2604. They are both very extensive works, are they not?—The Manchester Waterworks supply about 600,000 persons, and the Glasgow Waterworks supply nearly 500,000 persons.

2605. Are they both on the gravitating principle?—Both on the gravitating principle.

2606. How far is Loch Katrine from Glasgow?—About 37 miles.

2607. You have also had experience, have you not, in supplying towns by pumping from rivers to summit reservoirs?—I have not, to the same extent as by gravitation, but still I have had experience in those works too.

2608. As an hydraulic engineer, have you not carried out works on a very large scale?—I have laid out works connected with water in all ways. I have been largely connected with canals and navigations.

2609. What engine-power would it require to raise 10,000,000 gallons 100 feet in 24 hours?—About 1,300 horse-power, working constantly.

2610. Is that the net or the gross horse-power?—The net horse-power; reckoning the work done at 33,000 lbs. raised one foot high in a minute.

2611. What is the difference between net and gross horse-power?—The gross horse-power, is ordinarily considered one-third more than the effect produced; that one-third is lost in overcoming the friction of the parts of the engine. The best engines will do with rather less than that, but it is usual to calculate the power exerted at 45,000 lbs., and the weight raised at 33,000 lbs., one foot high, in a minute.

2612. Then is the gross horse-power what the Cornish engineers call the actual horse power?—The actual horse-power is the work done.

2613. Would not one-tenth of that quantity of horse-power be requisite to raise one-tenth of the quantity of water?—Exactly.

2614. And ten times that horse-power would be requisite to raise the same quantity of water in one-tenth of the time?—Ten times the power would be requisite to raise the same quantity in one-tenth of the time. Some modification of that would have to be made, because unless your pipes in all respects were in the same proportion, the friction would be greater by the greater velocity of the water passing through the pipes.

2615. Then the time being the same, the engine power varies as the quantity and the height?—Yes.

2616. Then it would take the same horse-power to raise 1,000,000 gallons 100 feet as to raise 100,000,000 gallons one foot?—The same, setting aside the same modification for the friction of the water through the pipes.

2617. What is the difference between the power required for pumping the sewage, and the power required for pumping pure water?—I can hardly state that, because I have had no experience in pumping sewage, but I should think the difference would be very small; the sewage, if it is much mixed with matter in suspension, may be a trifle heavier than the pure water. A cubic foot of pure water is 62½ lbs.

2618. Supposing the specific gravity of pure water to be 1,000, and the specific gravity of sewage to be 1,012, would not the difference of the horse-power be very small?—The proportion would be 0·012 additional, but I should suppose that the sewage water would vary materially in specific gravity according to its quality, whether it was rich or poor.

2619. Do you mean whether the water-supply is rich or poor?—No; whether the sewage water holds many materials in suspension in it or not.

2620. In the case of pumping sewage out of towns, I suppose you may consider that there are three different conditions: first, if the town is in a hollow or basin, like London, when there would be most pumping required; the second, when it is on a flat, like Manchester, when you would only have to pump it to a summit reservoir on the plain; and the third case, where it is on a hill, like Birmingham, where the sewage would fall by gravitation merely?—London is, as you say, at the bottom of a basin; and if the sewage had to be raised to the adjacent hills, of course that would be tantamount to raising the water to a reservoir of a given height, or to an elevated tank in a flat country.

2621. In case of the town being in a flat place, how would you get the sewage out of it into the country?—I think I should force it up to a reservoir

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reservoir, and then let it run out by conduits (which would be the cheapest way) to the place required by gravitation. I do not think that piping to convey the sewage water, after you have once got a sufficient elevation, would be the cheapest way; I should prefer to raise the water to an elevated situation, either by an artificial construction, or by taking it to a high point of land, and from there I should conduct the water by gravitation in proper open conduits in the same way as you would to irrigate land.

2622. Would those open conduits be cheaper than pipes?—Yes.

2623. Then how could you do that; for a short distance only, or for a long distance?—For any length.

2624. Are you referring now to iron pipes?—Yes, to iron pipes; no other pipes on a large scale would be suitable.

2625. Would not earthen pipes be suitable?—Not on a large scale.

2626. On a small scale they would be very cheap, would they not?—Yes.

2627. What sized main would you require to convey 62,000,000 gallons up a hill in 24 hours?—That would depend upon the height of the hill, and upon the velocity with which the water had to pass through the pipe.

2628. If the hill were to be 100 feet high, what sized main would you require?—To raise 62,000,000 gallons 100 feet high in 24 hours would require a pipe of six feet diameter, with eight feet head, or less of head, to overcome the friction in a mile, and a pipe of five feet in diameter, with a head, as it is called, of 15 feet in a mile. That is if you have to raise 62,000,000 gallons, which is about 100,000,000 cubic feet, it would require, in addition to the 100 feet to which you would raise it if you force it through a six-foot pipe, an additional eight feet per mile to overcome the friction; if you forced it through a five-foot pipe, it would require 15 feet to overcome the friction. That would be equivalent to a lift 115 feet to raise it 100 feet in the one case, and to a lift of 108 feet to raise it 100 feet in the other case.

2629. Supposing that the height of 100 feet remained the same, would there be any difference in the size of the main required if the reservoir were one mile or five miles distant?—Yes; if you were to raise the same quantity of water by forcing, you must add to the height to which the water is raised so many feet per mile to overcome the friction. If you take the case of ten feet in a mile, which is an ordinary allowance, it would be equivalent to raising the water perpendicularly 110 feet, so that for 10 miles it would amount to 200 feet.

2630. Then what is the ratio that you add per mile?—In that case I am supposing that you add 10 feet per mile; but it depends upon the size of the pipe, and upon the velocity with which the water passes through the pipe. The quicker you force the water the greater is the friction, and the greater is the power required to be exerted to raise the water.

2631. The smaller the main the greater would be the friction?—Yes, because you must force it with a greater velocity than through a larger main.

2632. What would be the thickness of the metal and the weight per yard which would be required for a five-foot main to support a column of 100 feet of water?—I do not think that a five-foot main was ever constructed yet, and therefore I can only state that to the Committee by calculation; but I have in the Glasgow Waterworks and in the Manchester Waterworks constructed pipes of four feet in diameter, and bearing considerable pressure; 250 feet of pressure in the case of the Glasgow Waterworks. The pipes for that pressure were 1⅝ inche thick; but I have calculated as nearly as possible the practical thickness for the pipes under various heads. If you took a five-foot pipe (although I do not think that that is a size to be desired), it would require a thickness of 1½ inche for100 feet of pressure; of two inches for 200 feet of pressure; of 2¼ inches or a trifle more for 300 feet of pressure; and of 2½ inches for 400 feet of pressure. Then I can give 2-foot, 3-foot, and 4-foot pipes at those various pressures. A 2-foot pipe would require to be three-quarters of an inch thick for 100 feet of pressure; seven-eighths of an inch thick for 200 feet of pressure; one inch thick for 300 feet of pressure; and 1⅛ inch thick for 400 feet of pressure. The 3-foot pipe will require to be one inch thick for 100 feet of pressure; 1⅛ inch thick for 200 feet of pressure; 1⅜ inch thick for 300 feet of pressure; and 1¾ inch thick for 400 feet of pressure. The 4-foot pipe, which is as large a size as I would recommend, would require to be 1¼ inch thick for 100 feet of pressure; 1½ inch thick for 200 feet of pressure; 1¾ inch thick for 300 feet of pressure; and 2⅛ inch thick for 400 feet of pressure. Those are not worked out merely theoretically, taking the computed strength of the iron; but there is an addition for what is required practically, to allow for imperfections in the casting of the pipes. Practically, those are the thicknesses that are required, and it is found that from no apparent cause, although the pipes are all proved at twice the pressure; occasionally a pipe bursts.

2633. Have you calculated the weight of lead required for jointing?—I have calculated the weight both by the yard and by the mile. I have taken the laying and jointing, which includes the lead, and the spunyarn which is always driven home before you put in the lead. The laying and jointing, which includes everything but the transport of the pipes, the cutting of the trenches, and the refilling of them, the top of the pipes being three feet below the surface of the ground; taking the actual cost of the works which I have constructed, a fair average for the work, taking neither an expensive work, as in the case of rock cutting, nor town works, as in the case of such troublesome districts to deal with as London, but in the open country, would be about 9 *s.* per lineal yard for 2-foot pipes, 13 *s.* per lineal yard for 3-foot pipes, 20 *s.* or 21 *s.* for 4-foot pipes. Of 5-foot pipes I have had no experience, but it cannot cost less than 30 *s.* per lineal yard.

2634. Have you calculated the weight of those pipes?—I have before me two specifications of the Glasgow Waterworks, in which the weights of the various thicknesses are given for 48, 42, 36, 33, 30, 24, 20, 18, and all the various sizes, down to two inches; that is the weight per pipe, and from the weights and the thicknesses I have calculated the weight per mile. The total cost per mile of piping, including laying and jointing, at each size of pipe will be generally this: A 2-foot pipe will cost from 4,000 *l.* to 5,000 *l.* a mile, according to its strength; a 3-foot pipe will cost from 6,500 *l.* to 10,000 *l.* a mile; a

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4-foot pipe will cost from 10,000 *l.* to 18,000 *l.* a mile; and a 5-foot pipe from 16,000 *l.* to 25,000 *l.* a mile, taking the price of iron at 6 *l.* per ton.

2635. What head of water is necessary to overcome the friction in a 2-foot main, a mile long, supposing it to descend by gravitation?—That again depends upon the velocity with which it passes through the pipes. If you take a 2-foot pipe, with three feet fall in a mile, it will deliver 2,500,000 gallons in 24 hours. With six feet fall in a mile, it will deliver 3,750,000 gallons in the same time; with nine feet fall in a mile, it will deliver 4,750,000 gallons; with 12 feet fall in a mile, it will deliver about 5,500,000 gallons, and with 20 feet fall in a mile, it will deliver about 7,500,000 gallons. This is a calculation from *formulæ*, showing the discharge of gallons in each day. I will put that in as a table, as it is very simple and very useful.

2636. Would the head which is required, be the same whether there were undulations in the ground or not?—Moderate undulations will make no difference; abrupt undulations which would interfere with the flow of the water, perhaps would have to be allowed for, but practically no allowance is made. I may also state that when the pipes are coated with asphalte in the way in which those are that I have been in the habit of using for the last 15 or 16 years, they will deliver a much greater quantity of water than any of the calculated results. For instance, at Glasgow the 4-foot pipes which were calculated to deliver 20,000,000 gallons in 24 hours with five feet fall per mile, have delivered 26,000,000 gallons with a fall of 3½ feet per mile; I can only account for that by two causes, either it is that the surface, which is like glass, is so smooth that it has rendered the conditions different from those which existed when the experiments were made by the various experimentalists on hydraulic velocity, from whose results our calculations are deduced; or that the size of the pipes is so much larger that the *formulæ* do not apply. The fact, however, is, that in the condition in which the Glasgow pipes were when the water was first introduced into them, they certainly delivered something like 40 per cent. or 50 per cent. more water than the calculated results, taking the *formulæ* which we are accustomed to use.

2637. Does the required head increase in the same ratio with the length of the main?—No; the direct head does, but the rateable head is the same; for instance, as I mentioned before, if you have water passing through the pipes with a certain velocity, which requires 10 feet fall in a mile, and if you have 10 miles of that sized pipes, you must add 100 feet to the height to be lifted; or if you are conveying it by gravitation, and have 200 feet of fall from your reservoir, 10 miles distant from the town to be supplied, you must take 10 feet in a mile, or 100 feet, off, in order to ascertain the available pressure on the pipes in that town.

2638. Is that calculation independent of the undulations, or of the rise and fall of the ground?—Yes; practically no undulations, except abrupt curves, will interfere with this result.

2639. Have you calculated the thickness and weight of the smaller distributing mains?—Those I have in a table of the Glasgow piping which includes all the sizes, and I will hand in that table. In calculating the prices which I have given, I have taken the iron at 6 *l.* a ton; the large pipes will probably be delivered at 5 *l.* a ton, but I have taken them in this table at both 5 *l.* and 6 *l.* a ton. The prices of iron for the last four or five years, have varied from 5 *l.* to 6 *l.* 10 *s.* or 7 *l.* a ton, but that of course depends upon the situation of the district; if you are close to Scotch iron works, you can get pipes for 4 *l.* 10 *s.* or 5 *l.*; but if you are at a distance from iron works you have to pay a higher price.

2640. If one town is on a hill, and another town is in a hollow, would the only difference in the cost of delivering the sewage of those towns be the cost of the engines and of the lifting main?—That and the annual expense of working.

2641. But would there be no other source of difference?—If you had a town on a hill, from which you could convey the sewage by gravitation, there would be no expense to incur, except the means of conveyance. If you had a town in the bottom of a basin, and had to elevate the water to the surrounding country, you would have the cost of the engine power; the first outlay for the pumps, and the main through which it would be pumped, possibly a reservoir, and then the actual expense of working.

2642. If the town were on the flat, would you force the sewage by engine power through the pipes, or would you rather build a reservoir at a certain height, and pump it up?—I have never had any experience in the case of sewage; but in the case of water, I should prefer to lift it to an elevated reservoir, and then let it flow by gravitation.

2643. Mr. *Ferrand.*] Could sewage be conveyed in stone tunnels?—Yes.

2644. Could you give the Committee any estimate as to the difference of cost between stone and iron for those tunnels?—Brick would probably be better than stone. In a brick country you would construct a brick culvert more cheaply than a stone one, and, *vice versâ*, in a stone country you would construct a stone culvert more cheaply than a brick culvert; but there is no doubt that either stone or brick would be cheaper than iron. The only difference is this, that you could not put a stone or brick culvert under pressure in the same way as you could an iron pipe; it would burst, or leak; but having got the sewage at an elevated point, you could conduct it from that point more cheaply in a culvert of stone or brick than in an iron pipe.

2645. Could you give the Committee any estimate as to the difference in expense?—I could do that; but it would require some little working out. I will put that with the other papers.

2646. In the manufacturing districts of Lancashire and Yorkshire, are not a great many of the large towns situated within easy reach of stone?—In Yorkshire, especially, they are; and in Lancashire also.

2647. Are you aware that the water to the Bradford Waterworks is conveyed for a very considerable distance by a stone tunnel from the valley of the Wharfe?—I am not acquainted with the circumstances in that case; but, in the case of the Halifax Waterworks, which I constructed myself, all the conduits, until we begin to distribute the water, are of stone, or of brick, and they answer perfectly well. In Manchester, also, all the covered conduits for conveying the water, *J. F. Bateman*, Esq.

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water, are either of stone or of brick, to the point where we begin to distribute. And, in Glasgow, except where we pass three deep valleys or gorges, between Loch Katrine and the Mugduck Reservoir, a distance of 27 miles, the whole of the water is carried by tunnels or covered culverts of masonry. In fact, it is one continuous tunnel the whole way.

2648. Have you been acquainted with the carriage of sewage?—Yes.

2649. Was that by pipes underground, or on the surface?—I know many places which are supplied with sewage water, especially the case which has been so often referred to, of Portobello, near Edinburgh.

2650. Could you give the Committee some other instance than that?—There is the case of Mr. Harvey, of Port Dundas, near Glasgow. That gentleman keeps 1,700 cows; he keeps all his cows in byres, as they are called in Scotland, and the liquid manure that they make is passed into a tank, and there agitated and pumped up into large vats on the summit of the hills; and thence it is conveyed in small iron pipes. The ground on which he feeds his cattle is watered by hose and jets, and a man walks about and distributes it all over the ground. That is the largest application of sewage in that way, that I know anywhere.

2651. Is all that done on the surface?—It is all done on the surface, from the jéts; they have iron pipes from the tanks in which the sewage water is stored, which are carried up and down the fields, and then the sewage is distributed by pressure from those vats, acting upon the pipes, and distributing the water.

2652. Mr. *Tite.*] That is the same as Mr. Mechi's plan, is it not?—I have not seen Mr. Mechi's farm, but probably he adopts the same plan.

2653. Mr. *Hibbert.*] If it were decided to convey the sewage in iron piping, would it not be desirable to convey it in two pipes of two feet in diameter, rather than in one pipe of four feet in diameter?—Two 3-foot pipes are only equivalent to one 4-foot pipe. If you want the area of a 4-foot pipe, which is 13 or 14 feet, you must have an equivalent area which works out as nearly as possible to two 3-foot pipes. You may lay 4-foot pipes with tolerable security and safety; and a 4-foot pipe I have often laid, because the larger the pipe the more economical is the system.

2654. Is there any danger with a 4-foot pipe?—There is danger with all pipes; but, of course, the larger you get the pipe, the more economical it is with respect to the quantity of water which it will convey.

2655. You stated that the pipes at Glasgow are asphalted; what is the extra expense for asphalting?—About 5*s.* a ton. Those at Manchester were asphalted inside and outside on Dr. Angus Smith's principle about the year 1849, 15 or 16 years ago, and when well done, they answer very well.

2656. How long does it last?—I saw a number of pipes the other day which, after 10 or 12 years, were as fresh as when they were first done; on the average, I think it would add 10 years to the pipe.

2657. Would the sewage have any effect upon it?—I think common sewage would not; there may be ingredients from chemical manufactories which would be injurious to it, but I do not think that ordinary sewage would be injurious.

2658. You have stated that earthenware pipes are not suitable for the conveyance of sewage; that applies principally to their being under pressure, does it not?—Yes.

2659. One of the systems which have been before the Committee proposes to have earthenware pipes to distribute the sewage over the farms; would you have any objection to that?—No; you may distribute the sewage over farms in very many different ways. In the case of my own sewage in the country, I collect the sewage of the house in a large meadow, and carry it by sloping troughs all over the land as I require it. I find that a cheap mode of doing it, and a very effective one.

2660. You stated that 4-foot pipes would cost from 8,000 *l.* to 18,000 *l.* per mile; what is the reason of the great difference of cost in those pipes?—The thickness varies according to the amount of pressure. If the pressure varied from 100 feet to 400 feet, the thickness would vary from one and a-half inches to two and a-half inches, and the cost would vary accordingly.

2661. Dr. *Brady.*] Do you use your sewage on your own estate?—Yes, to a limited extent.

2662. What may be the number of the inhabitants whose sewage you use?—I live there during a part of the year only, and during that time the population of my house will be about 25; but probably you may take 15 or 18 as the average for the year. All my laundry is conducted throughout the year there, and I have a tolerably large establishment.

2663. How many acres do you put this sewage over?—About three acres; it is not done very economically, but it happened to be a convenient place for it.

2664. What has been the effect of the application of the sewage of those 18 persons over that quantity of land?—It certainly improves the land, and produces very good grass, and saves all manure. I do not manure in any other way that portion of the meadow to which the sewage is applied.

2665. Is the produce from that land to which the sewage is applied, much larger than from the adjoining land?—No, I think not. I think that the land which is manured by the common farmyard manure, produces quite as much. The application of the sewage is done very roughly, but the grass is certainly much thicker at the ends of the troughs, and I have noticed that the cattle graze there, after a short time, just as freely and readily as they do on any other part of the meadow.

2666. Have you found any inconvenience from that application of the sewage?—There has been no inconvenience. The most beautiful application of sewage that I have seen is at Carlisle.

2667. Do you refer to the case of Dr. Angus Smith?—Yes.

2668. Do you find that three acres of land do not require any further manure than that which is produced by those 18 persons?—They have all the refuse of the laundry during the whole year, in addition to the sewage.

2669. Do you consider that that amount of sewage is sufficient for the three acres of land?—No, I do not think it is. I think that some part of that land wants manure in addition to that.

2670. Mr. *Ferrand.*] Do you think that you would

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would have sufficient sewage for two acres of land?—If I did it systematically and properly, and with a view to the most economical and the most effectual way of applying the sewage, I am not at all sure that the produce of that house tank would not be quite sufficient for four acres of land; but as I do it, I do not think it is sufficient.

2671. Does that sewage include the manure produced by horses and cattle?—No; the manure from the horses, and cattle, and piggeries, all goes in another direction; those meadows receive the sewage from the house and water closets, and other things.

2672. And you find, that from the number of persons which you have mentioned you have not sufficient manure for four acres of land?—I am only there during the autumn and winter, and therefore, on the average, there will not be more than 15 persons, perhaps, through the year.

2673. Mr. *Caird.*] What is the quantity of water that passes daily through the conduits at Glasgow, from Loch Katrine?—From Loch Katrine it would be about 20,000,000 gallons a day. The conduits will take 50,000,000 gallons a day.

2674. It has been stated in evidence that the quantity of sewage from London is 62,000,000 gallons a day, so that the quantity which you mention is something like the cubical content of the whole of the sewage of London. What is the size of the conduits that carry that quantity of water?—The conduits from Loch Katrine are eight feet in diameter, with 10 inches fall in a mile, and they are filled with that quantity of water six feet deep.

2675. Mr. *Tite.*] Are they cylindrical in shape?—Not quite; all the centres are within themselves.

2676. Then their capacity is much greater than you would call into play?—They are calculated to take 50,000,000 gallons a day; and when we are taking 50,000,000 gallons they will run from five feet six inches to six feet deep.

2677. Would conduits or culverts of that description do perfectly well for distributing sewage by gravitation?—Perfectly.

2678. But would they do for pumping?—Not so well, because the culverts would be under pressure, and there would be no sufficient cohesion to resist the pressure.

2679. Would you describe what material, and in what way those culverts are constructed?—From the first 9 or 10 miles, from Loch Katrine, we go through mica and clay slate, where all that we had to do was to get a hole through the rock, about eight feet high, and eight feet wide.

2680. Had you not to puddle or cement that hole?—Not at all; here and there, where the rock was tender, we had to line it, for the purpose of preventing the rock falling. When we got into the old red sandstone, the greater portion of it had to be lined, and made water-tight. The sandstone of the district, is very similar in quality to the new red sandstone.

2681. When the tunnels were through the sandstone, had the rock to be puddled?—It had to be made in hydraulic cement, which we always use in such cases.

2682. Through the open country, of what material, and in what manner were the culverts constructed?—They were constructed of masonry, inverts, sides, and crown, and either concreted behind (which is preferable to puddling), or puddled. There is a great objection to clay puddling round a culvert cut along a hill side; the water passing down the hill side, and going through the new-made ground, gets behind the clay, and gradually melts it, and dissipates it; and therefore it is always better to surround it with concrete.

2683. When the conduit is through the open ground, is it covered?—It is always covered in the case of the Glasgow works.

2684. You have spoken of the application of sewage to Mr. Harvey's dairy farm; do you know over how many acres of land that manure is used?—No, I do not.

2685. *Chairman.*] Is the friction greater through a brick or stone culvert than through an iron main?—If the culvert is well constructed, and of a large size, I do not think that there is any material difference.

2686. Then you would not require a greater head?—You would not require a greater head, if you took the old formula, on which we depend; it applies very accurately to culverts, whether made of stone or brick, but it is not large enough for well-made glazed pipes.

2687. Will you hand in a table of the differences in the prices of stone or brick culverts and iron mains?—Yes.

2688. Mr. *Tite.*] The form that you adopt for the culverts is rather larger in area than a cylinder, is it not?—Yes.

2689. And it has the advantage of a flatter bottom?—For pure water that is the best form that you can get, because you have no matter in suspension to carry along with the water, and therefore you do not want a greater velocity at the bottom of the pipe.

2690. Would that apply to sewage?—No; you want a tolerably narrow bottom for the sewers to convey sewage, on account of the quantity of matter in suspension.

2691. Then the egg shape is the best, is it not, with the small end downwards?—Yes.

ARTHUR WHITEHEAD, Esq., called in; and Examined.

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2692. YOU are a member of the Institution of Civil Engineers, are you not?—Yes, I am.

2693. Are you the county engineer and surveyor of Somersetshire?—I am.

2694. Have you paid much attention to the drainage and water supply of towns?—I have, for the past 15 or 16 years.

2665. Have you at all considered the question of sewage utilisation?—I have.

2696. Have you had any assistance from chemists?—I had partial assistance from Mr. Herapath, of Bristol, but I have never yet carried out any works for the utilisation of sewage.

2697. Have you carried out works for combined water supply and sewage in towns?—Yes, in Ottery St. Mary, and Ilfracombe, in the county of Devon; in Dorchester, Burnham, Wells, Weston-super-mare, and partially in Taunton, in the county of Somerset.

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2698. Are the outfalls of the sewage of those towns in fresh water rivers?—They are, with the exception of Ilfracombe and Burnham; those two have their outfals in the Bristol Channel.

2699. Did you prepare plans and estimates for intercepting the sewage of Exeter, and distributing it over land in the valley of the Exe?—I did.

2700. Were the works carried out?—They were not carried out. It is about 14 years since that report and plan were prepared, and at that time people were so unwilling to believe in the advantage of making any use of the sewage that the plan was dropped; but now, I may say, it is revived, and I think that in the course of the next year or two it will be carried out.

2701. Persons, you think, have now found out the advantage of making use of the sewage, and therefore they have taken up that scheme again?—Yes.

2702. What would have been the cost of those works?—Speaking from recollection, I think the estimate was 45,000 *l.* I will not say that the work will be done, but I have heard that the landowners, of whom the Earl of Devon, who lives in the valley of the Exe, is one, are considering the propriety of using the Exeter sewage.

2703. Did you make any detailed survey of Exmouth?—I did.

2704. Under whose instructions?—Under the instructions of the Local Board of Health of that town. In 1854 those plans embraced the supplying of the town with water, and also the intercepting of all the town sewage, and distributing the sewage over a large amount of meadow land, 70 acres, which lies very near the town; and possibly that work would have been carried out, but for the fact that the Board changed its constitution, and as it very often occurs in country boards of health, when the members of one board retire from office, their successors refuse to carry out their plans; and therefore the matter dropped there; and from that time, no work of any importance has been done at Exmouth, either to supply it with water, or to get rid of the sewage; the sewage is not even taken from the houses by properly constructed drains.

2705. Were any sewage works carried out by you at Sherborne?—I did not carry out the works, but soon after they were carried out by another engineer, I was directed by a gentleman who owns the land in the neighbourhood of the outfall, to examine into the matter. I made a report to him of the fouling of the river, and I recommended that the sewage should be utilised, and gave him plans and estimates for doing it; he has not carried out those plans, and, with the exception of a very slight and rude mode of collecting the solid part of the sewage, nothing has been done at Sherborne.

2706. Were those works first carried out by the Local Board of Health?—They were.

2707. In what year?—About the year 1855.

2708. Was it at the request of the Local Board of Health that you examined into the matter?—No; at the request of a gentleman who owns the land; he complained that the sewage entered the river, and prevented his cattle from obtaining pure water.

2709. What did you advise in that case?—That the sewage should be intercepted, and carried over his farm.

2710. Has that work been carried out at all?—It has not, with the exception of a rude attempt to intercept a small part of the solid portion of the sewage.

2711. Have you not visited a great number of outfalls and rivers since this Committee has been appointed?—I have visited Weston-super-Mare, Wells, Exeter, Ottery St. Mary, Exmouth, Taunton, Dorchester, and Sherborne.

2712. Did you examine the rivers into which the sewage of those towns is carried?—I did.

2713. Beginning with the town of Weston-super-Mare, how many inhabitants has that town?—It contained at the last census 8,038 inhabitants.

2714. And how many gallons of sewage are discharged into the river daily?—The quantity of sewage, so far as it may be called sewage, apart from the water supply, or rather the road drainage, which is discharged at the outfall, is about 75,000 gallons per day.

2715. Does the drainage of the roads go with the sewage?—It does.

2716. How much does that amount to?—I gauged this in a very dry season, when there was very little road drainage coming through the outfall.

2717. Is that watercourse maintained by the surveyors?—Yes; the town of Weston-super-Mare stands in a flat district, and the watercourse into which the sewage is discharged, forms one of the drains which drains the district, and is maintained by the Commissioners of Sewers of the County of Somerset. The Rhyne runs through a village about one mile from the outfall, containing 440 inhabitants, and the whole of the Rhyne from the outfall to this village, and beyond it, is in a most foul state; the cattle refuse to drink the water, and a case is within my own knowledge where a landowner had to pay his tenant 60 *l.* as compensation for the loss his cattle had sustained by reason of the fouling of the stream.

2718. Did the farmer claim only 60 *l.*?—He claimed 90 *l.* The landowner has since had to provide artificial drinking places for his stock at a large expense. The water below the outfall is too foul for eels now to live in; it formerly required cleansing once in seven years; it now requires annual cleansing. I may state further, with regard to the Weston sewage, that it is carried into an artificial well, and from thence it is lifted by steam power into tanks, where it undergoes precipitation and deodorisation.

2719. It falls into a well, and is pumped from thence into tanks?—Yes.

2720. It then undergoes the lime process, does it not?—Yes, it does.

2721. Does that lime process succeed in purifying the sewage?—Very far from it, and I take it that one cause is this; that the lime is not applied in the most effective manner. I think it is the same as the smoke consuming furnaces; it depends upon the discretion of the man who puts on the coal whether it is effective or not.

2722. Have you ever known lime to succeed in purifying the water?—I have known lime to succeed, but this evil attaches to it, that it kills the fish.

2723. And does it not also render the water unwholesome for drinking?—Quite so.

2724. Would it be unprofitable as a commercial speculation?—Certainly.

2725. You think that it would not be good for agricultural purposes?—No, as far as stock is concerned.

2726. Then would you say that the lime process is a failure?—I say that the lime process, as it has been carried out in this case, is quite a failure; but, I think that it admits of great improvements.

2727. Previous to this lime process being used, the cattle drank the water of the stream, and now they cannot drink it, and the fish die in the stream; is that so?—That is so.

2728. What proportion does the quantity of sewage which is discharged into the stream, bear to the stream itself?—In a dry season the quantity of sewage discharged is rather more than the volume of the stream itself. With the permission of the Committee I will read a letter which I have received from the parish authorities of Uphill, with regard to the foulness of that stream:—"Sir, The bad, foul smells arising from the deposit left in the Uphill Great Rhyne, by the emptying of the sewage water into it from the Weston Sewage Works since the sewer has been made into the Rhyne by the Commissioners of the town of Weston-super-Mare, is so bad that we are in continued dread of some malignant fever breaking out in the parish in hot weather. The Commissioners of the town cleaned out the bottom of the Rhyne only nine months ago, and now there is a deposit of two feet near the mouth of the sewer, gradually reducing the thickness to the outlet of the sea one mile and three quarters. The fish have been destroyed ever since it has been emptied into the Rhyne, and the health of the parish is not considered near as good as formerly. Several deaths have occurred, although it cannot be immediately laid to the nuisance coming into the Rhyne, yet it is believed to be a great cause of illness. Yours truly, Charles Whitting, Churchwarden of the parish of Uphill."

2729. How many inhabitants has the city of Wells?—6,871.

2730. What stream takes the sewage of that town?—It is carried into a stream flowing about half a mile below the city of Wells.

2731. Is that stream very much fouled?—It is remarkably so.

2732. Is it fouled immediately at the outfall?—It is.

2733. Is it a rapid stream?—It is a rapid stream.

2734. Then is not a great deal of the filth and pollution carried someway down that stream?—It is.

2735. Is there much annoyance from the fouling to the people below?—At the mills half a mile below the outfall, I have seen very large quantities of solid matter, pure *fæces*, taken up from the grating, and the stench at the mill is so bad, that the miller can hardly remain in the house.

2736. And that is half a mile down the stream, is it not?—Half a mile down the stream.

2737. Has it a very foul appearance?—Very foul.

2738. What is the quantity of house sewage discharged into that stream daily?—About 100,000 gallons.

2739. Is the sewage of Exeter carried into the River Exe?—It is carried into a mill stream taken from the River Exe.

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2740. And it flows back again into the River Exe, does it not?—It does.

2741. What is the state of the river on the eastern side of the bridge?—On the eastern side of the Exe Bridge, the state of the river is very bad; it was very bad when I saw it, one day last week. There the town sewer discharges itself close to the Exe Bridge, and the whole bed of the river is one mass of pollution.

2742. Is not that very offensive, and a great annoyance to the inhabitants?—Yes.

2743. And is the mill lead as bad?—It is very offensive at times.

2744. Would the sewage of Exeter admit of being utilised?—The sewage of Exeter would admit of being utilised with the greatest ease.

2745. Why would that be the case?—The whole of the sewage could be intercepted very easily, by one long sewer running from north to south, and carried over the valley of the Exe, which contains about 3,000 acres within the reach of the sewage.

2746. It would fall by gravitation?—It would fall by gravitation over 2,000 acres, and the other 1,000 acres would be only about 35 feet above the level.

2747. You would hardly require any pumping at all in that case?—Hardly any.

2748. What is the population of Exeter?—I have put it at 39,000; I am not quite sure about it, but I think it is about 40,000.

2749. Are there any sewer works at Ottery St. Mary?—Yes, I carried them out myself.

2750. How long ago?—In the year 1852.

2751. What sort of mains did you use?—The whole of the drainage of that district was carried out by stone-ware pipes.

2752. Did you find that plan to succeed?—Remarkably well.

2753. What is the number of inhabitants in that parish?—There are 4,421 inhabitants, and of that number about 3,300 reside within the district that was drained.

2754. Were those works found to be beneficial?—They have been remarkably beneficial.

2755. Was there a stream running through the town previously to those works being carried out?—There was.

2756. Did that stream receive the drainage of the place, and furnish the water supply of the place also?—To all appearance it did.

2757. Was there any evil consequence from that?—The consequence was that the town was never free from a low fever, which is well known in the place, and called the "Ottery fever."

2758. What course did the clerk to the Board of Guardians take?—The clerk to the Board of Guardians reported that Ottery St. Mary was the only parish in the union in which disease prevailed to any very great extent.

2759. What number of cases were there in the year?—Between July 1848 and January 1849, 131 cases of fever occurred in that one place.

2760. Was that among about 4,000 inhabitants?—Yes.

2761. Since the sanitary works have been carried out, what has been the effect?—A leading medical man in the town states, that there has been no serious epidemic in the place, and that there has not been the average amount of sickness which more or less prevails at certain seasons of the year.

2762. When the works were carried out, did anybody

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anybody complain?—A leading farmer of the parish, who had previously used the stream for irrigation, brought an action against the Local Board of Health, and claimed 1,000 *l.* for what he considered to be damage to his property.

2763. He used the water of the stream before, and he could equally use it now, could he not?—He could.

2764. But the stream now does not contain the sewage which it did before; is that so?—Just so.

2765. And because it did not contain the sewage, he laid the damage at 1,000 *l.*?—Yes.

2766. Mr. *Ferrand.*] What was the result?—He found that he had no case of action, and he abandoned it.

2767. *Chairman.*] What amount of sewage was there discharged into that stream?—70,000 gallons per day.

2768. How many villages are there on that stream?—Six below that outfall, containing a population of about 300 persons.

2769. How far apart are those villages?—Varying from one mile to two miles apart.

2770. For all that distance, does the amount of the sewage produce discolouration of the water?—It does; for three quarters of a mile below the outfall, the discolouration of the water is very apparent.

2771. Do you consider that there is injury done to the persons within the towns by the sewage which falls into the river?—I think so, for this reason: that where the sewage has become well mixed with the river water it cannot be readily detected, and then it is more pernicious in its effects than where it can be seen; it gradually weakens the constitutions of people, and they cannot account for it.

2772. Do you know, by experience, that water containing sewage, though apparently clean, is baneful to the health?—That is so.

2773. And, in fact, is it more dangerous than water which looks foul?—I think so.

2774. What becomes of the sewage of Exmouth?—The sewage of Exmouth is carried to two outfalls. In the case of the one outfall, it is carried over a long sandy foreshore, and finds its way into the estuary of the Exe; in the case of the other outfall, it is carried into the Exe, about 70 yards from the bathing place, which is used by the inhabitants of the town.

2775. Does it flow over that foreshore in pipes?—No; it is left open.

2776. Then does it not produce a great smell there?—It does.

2777. And is it offensive also at the other outfall, near the bathing place?—It is.

2778. Could the sewage of that town be easily utilised?—It could.

2779. Is there any adjoining meadow land over which it could be poured?—There is.

2780. Would they have to pump it in that case, or could it be conveyed by gravitation alone?—You would have to steam-pump it.

2781. To what height would it be necessary to pump it?—About 20 feet.

2782. What is the population of Taunton?—The population of Taunton is about 14,660.

2783. And what becomes of the sewage of Taunton?—The sewage of Taunton is carried by three outfalls into the River Tone.

2784. What quantity of sewage is discharged into the river?—I can only estimate it at 250,000 gallons per day.

2785. What is the condition of the river, in consequence of the sewage being poured into it?—The River Tone, for two miles below the town of Taunton, is in a most foul state.

2786. Is there a Local Board of Health at Taunton?—There is.

2787. Have they done anything to remedy this nuisance?—They have not.

2788. Have they not been threatened with prosecutions, in consequence of the offensiveness of the stream?—They have been threatened with an action, by parties who live on the river and have to undergo the annoyance of the foul smells and foul water. I have, here, a protest, signed by a gentleman living in the neighbourhood of Taunton, on the river, stating how foul the river is.

2789. What is the population of Dorchester?—6,823.

2790. What becomes of the sewage of Dorchester?—It passes into the River Froom, about a mile below the town.

2791. What is the quantity of the sewage?—180,000 gallons per day.

2792. How far is it from the sea?—It reaches the sea after a course of about 20 miles.

2793. How many towns are there in that distance?—I cannot state the number, but there are many villages, and the town of Wareham.

2794. Do all those places obtain their water supply from this river?—They do, more or less, no doubt; but I cannot state it as a matter of fact.

2795. Does the town of Wareham obtain its water supply from this river?—I do not know.

2796. What is the state of the river?—It is in a most foul state; for more than half a mile down the river from the outfall, the whole of the stream is quite saturated with sewage.

2797. Has the town of Dorchester been properly drained lately?—It has, within the last six years.

2798. What is the population of Sherborne?—5,500.

2799. Is the sewage also carried into the river?—It is.

2800. There was a report made of the state of this river in the year 1856, was there not?—There was.

2801. What is the present state of the river?—A great deal worse than it was then.

2802. What was the amount of the discharge of the sewage then?—At that time it was 120,000 gallons daily, and by gauging estimates it is now 140,000 gallons.

2803. Have the drainage works been more completely carried out?—They have.

2804. What is the state of the stream now?—The whole stream, for a mile and a half from the outfall, is one mass of sewage, as you can see by walking on the banks, and observing the different substances clinging to the sides.

2805. Does it contain any fish?—It does not.

2806. Is it used for water supply?—The farmer occupying the lands on the northern side of the river has been obliged to dig artificial places for his cattle, because they cannot touch the water in the river now.

2807. That of course, costs him a great deal?—It does.

2808. Has he brought any action against the Local Board of Health?—He has not.

2809. Does the river smell very badly in summer?—It does.

2810. Does any town obtain its water supply from that river?—I think not.

2811. You are of opinion that those streams which contain sewage, and yet do not show it, are worse than those which do show it?—I am.

2812. Have you drawn out a comparison of the deaths by drinking foul water, and by war, and will you state that shortly?—During the 22 years of the Peninsular War, the number killed was 19,796, and during the outbreak of the cholera in 1848–49, the deaths amounted to 72,180. At the battle of Waterloo, the amount of British killed on the field was 1,771; in Newcastle, in the year 1853, the amount that died of the cholera was 1,543.

2813. Are the rivers in Somersetshire very generally used for drinking purposes?—They are.

2814. Are there any epidemic fevers traceable to that cause?—I cannot say that they have been traced palpably to the drinking of polluted water, but there is no question that fevers and epidemic diseases do exist to a great extent in our villages and small towns.

2815. Are you aware whether it is of any avail to filter the water?—I think it is of none.

2816. Then, in fact, though a town filters the water that it procures from a river, still the injurious qualities of the sewage will not be taken out of it; is that so?—I think so.

2817. Then, in the case of London, the filtration is of very little benefit?—Very little, so far as the sewage is concerned.

2818. Are there provisions in certain Acts against gas and other refuse being drained into streams?—There are.

2819. Do not you think that there might be a similar provision as to sewage?—Yes, I think there might be.

2820. Would sewage or gas-refuse be most baneful to health?—I think that the gas-refuse will be the worst.

2821. Supposing that a town prevented its sewage from flowing into the river, and that other towns in the same catchment basin above it would not do so, would it not be useless for that particular town to take those precautions?—If you deal with the matter at all, you must deal with the whole of the catchment basin; of course, if one town below does it, and the other town above does not, no real benefit will be obtained.

2822. It would be of no avail for only one town to do it in the catchment basin?—It would not.

2823–4. Is this evil increasing from the more extended use of water-closets and better drainage?—It is.

2825. Can you suggest any remedy?—The only remedy that I can suggest, is to return to the land the sewage of our towns; in fact, to do that which we all know is done in the case of farming. No manure made by cattle is allowed to be removed from a farm. Nature's system of production and reproduction is carried on there to its greatest extent. Farming is considered to be most productive when it is carried out on that principle, and the same principle must be carried out with respect to human sewage.

2826. Then, in fact, the only means of curing this great evil of the pollution of the streams is by the utilization of the sewage?—Yes.

2827. And will it never be cured until that is adopted?—I think not.

2828. Mr. *Tite.*] Do you imagine that the utilization of the sewage in towns that you have referred to in and around Exeter, would be a very costly process in the first instance?—I do not.

2829. Would it be done by a tank in the first instance?—It would be arranged by means of carrying one long line of sewer to intercept all that is now discharged into the Exe, running that newly-made sewer into a covered reservoir, and letting it go by gravitation, as far as it would, over certain lands, and steam-pumping it over the rest.

2830. Then, after it had been so cast upon the land, the sewage water would be deprived of its noxious ingredients, and be restored to the river in a state not injurious to human life?—I think so; there is no medium that acts so completely as a deodoriser upon sewage matter as the land itself.

2831. What experience have you had on that subject?—My experience is only on a small scale, having tried it in gardens.

2832. Have you tried it on a scale sufficiently extensive to justify that opinion?—I think so.

2833. What is the greatest extent of land to which you have applied it?—Under half an acre.

2834. Where was that?—At Weston-super-Mare. I would add to that, that I believe that we shall never make the best of town sewage until we separate the fluid portion from the solid portion, the urine being the part which contains almost the whole or a great portion of the fertilising matter in the sewage; and I think that, to make the most of town sewage, we ought to get the urine undiluted, and then from that manufacture dry manure.

2835. That is obtaining the urates?—Quite so.

2836. How is that to be done?—It is to be done by a totally separate system of drains; one system of drains taking the urine, and the other system taking the solid portions of the sewage of the town; and I am of opinion that the value of the urine would be immense, compared with the small cost of the pipes laid to collect it.

2837. But then, in the using of a water-closet, is it possible to make a choice, so as to separate the urine from the solid matter?—It is quite possible to arrange the closet in such a way as to take the urine on one side and the solid matter on the other; but at the same time that is not of the first importance, because there is a great quantity of urine which might easily be collected without resorting to that arrangement.

2838. Without condescending to those refinements, do you think that the simpler operation of allowing the sewage water to spread over the lands nearer town would answer the purpose, and would be commercially successful?—I do not think that it would be successful to use our sewage water without having taken from it the urine; I think that the urine is too valuable a commodity to be allowed to go diluted to the outfall. The sewage, as discharged, is of very small value as compared with what it ought to be, and I believe that many warm streams are quite as valuable for irrigation as a great deal of the town sewage that we get in the country towns. The quantity of suburban land in country towns bears a much larger proportion to the land that is built upon than is the case in London.

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2839. But confining yourself to the question of utilizing and making commercially valuable the sewage of a town like Exeter, without the refinements to which I have referred, do you imagine that at Exeter the sewage water could not be poured over the meadows, so as to make it worth the while to pay the expense of doing so, and thereby destroy the offence which at present exists?—My answer is, that I consider that it would be a commercially successful system, but that it would not be so successful as it ought to be, and would be, if the urine were taken out of the sewage.

2840. But my question simply refers to the utilization of the sewage as we find it; could it or could it not be done, in your experience?—It could be done.

2841. Mr. *Adderley.*] You have mentioned many cases of towns polluting rivers; can you mention any one case of a town successfully getting rid of that nuisance?—I cannot.

2842. Do you think that any such plans as you have described would be applicable to towns of 100,000 inhabitants?—I do.

2843. Mr. *Ferrand.*] You stated that one Local Board or Town Council were in favour of carrying out some scheme for the purpose of utilizing the sewage, and that in the following year another Board put a stop to the scheme of their predecessors; is it your opinion that, to enable the sewage of towns to be successfully applied for fertilizing the land, an Act of Parliament must be passed?—It is.

2844. During your inquiries, have you entered much into the question of injury to cattle from drinking the polluted water?—Not as to the value of the cattle lost, but as to the matter of fact that the cattle cannot drink the water when it is polluted by the sewage; I cannot state the loss that the farmer has sustained.

2845. Are you aware of the injury which arises from the foul water to the milch cows?—I am not.

2846. Are you aware that the value of a grazing farm, watered only by sewage water, is more materially decreased, so far as drinking purposes are concerned, than if it is watered by clear spring water?—I have only this case within my own knowledge, which I have alluded to.

2847. Milch cows, if they have no other drinking water on that farm through which the sewage passes, must have that water all brought from elsewhere, must they not?—Yes.

2848. Have you had it distinctly brought under your notice, that the drinking of that water has been injurious to the cattle?—Yes, I have.

2849. Does the fouling of the water destroy the fish?—It does.

2850. Do you know any instance in which the fish has been destroyed where it has been valuable to the owner of the property?—I do not.

2851. But you know that the fouling does destroy the fish?—I do.

2852. Have you ever tasted any fish caught in this muddy water?—I have.

2853. What is the effect of that water on the taste of the fish?—We can distinguish a trout which is caught in the sewage part of the river from one that is caught in the clear part.

2854. Is not the fine flavour of the trout destroyed by this muddy water?—It is not quite destroyed, but it is very much injured.

2855. With regard to these streams passing through those large towns, is it not customary for the people in the town to throw cats and dogs and all kinds of rubbish into the stream?—It is made a receptacle for all kinds of refuse.

2856. Do you consider that the law is sufficiently stringent to be put in force against those persons?—I do not.

2857. Is there a general complaint that that is the case?—I have heard it generally stated that that is the case.

2858. Are there any manufactories in the neighbourhood of those towns to which you have referred?—No; with the exception of Ottery and Dorchester.

2859. Are there none in the county of Somerset?—There are a great many in the county.

2860. What do they consist of?—Partly broadcloth manufactories and lace manufactories; I think that these are the principal ones.

2861. Are there any chemical works?—Not that I am aware of.

2862. Is there much refuse from those mills flowing into the streams?—A great deal.

2863. Are you aware whether the manufacturers take any steps themselves to abate such injury from the refuse from those manufactories?—I am not.

2864. And is there no redress for the owners of the fishing, or of the streams, except by an application to the superior courts?—There is none.

2865. Have you paid any attention to filtering works?—I have.

2866. Is it your opinion that those manufacturers might reduce, to a considerable extent, the damage which they do to the streams, and to their neighbours, by filtering works?—It is.

2867. Is it your opinion that there ought to be some law to compel them to reduce the injury which they now inflict upon the public?—It is.

2868. Have you seen any instance of sewage applied to land?—Only on a very small scale.

2869. But where you have seen it, do you consider it valuable?—Very valuable.

2870. You have mentioned the refuse of gasworks flowing into those streams. You are aware, are you not, that there are heavy penalties against any person or any company turning the refuse of gas works into any stream?—I am.

2871. Is there any difficulty in catching them doing so?—I do not, myself, know a case in Somersetshire where any gas works do pollute a stream.

2872. But supposing that a gasworks were erected anywhere on the borders of one of those streams, and that they had a drain connected with the stream, have they not it in their power to drain the refuse from their works into the stream?—They have.

2873. Do you know any gas works which has its drains connected with a stream?—I do not.

2874. Dr. *Brady.*] You stated that there was a farmer who threatened to bring an action against the authorities of Ottery St. Mary. How many acres of land did he cultivate?—Fifteen, I think.

2875. Did this river or stream which you allude to pass over those 15 acres?—It did.

2876. What was the population of that district?—About 3,000.

2877. And did the whole of the sewage of the 3,000 people go over it?—Not the whole, simply the

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the sewage of that portion who were on the banks of the stream.

2878. What might be the population whose sewage is now going over the 15 acres?—About 500 of the inhabitants.

2879. Did that proportion increase the growth of the grass and crops?—It did, to an enormous extent; in fact, the land was known by the name of the land of Canaan, all over that part of the county of Devon, because it was so very good.

2880. Then that would be upon the proportion of about 30 or 40 persons to an acre?—Yes.

2881. Do you think that that proportion would be sufficient?—Too much.

2882. What would be, in your opinion, a proper number of inhabitants whose sewage you would apply per acre?—From seven to ten persons.

2883. It has been stated in evidence before the Committee to-day, that a gentleman applied the sewage of 15 persons over four acres of land, and he also stated, that if it were properly applied, it would be quite sufficient for those four acres; do you think that he was right?—I do; my own opinion is, that from seven to ten persons is a sufficient proportion. I heard the evidence of Mr. Bateman on that subject, and I thought that it was a very fair statement.

2884. *Chairman.*] You spoke of catching the urine, but if I understand you rightly you intend to utilise the sewage water all the same?—Quite so.

2885. And you would still think it worth while to erect the sewage works?—I should.

2886. Your only objection is to separate the urine, in order to manufacture a dry manure?—Quite so, and to make the sewage more valuable; to get the greatest amount of value out of the town sewage. I think that the urine by itself would give a far greater profit than would be realised by allowing it to go diluted.

2887. Then you would irrigate with the town sewage and have a dry manure to boot, would you not?—Yes.

2888. Then how would you transport that dry manure to the land?—I should drill it with the turnips and take it by carts.

2889. Is it true that the carriage of manure by suspension in water is much cheaper than by carting?—That is a question that I can hardly answer.

2890. If you had some substance which was soluble in water, and had pipes extending into the country, would it be cheaper for you to put that substance into water and take it in that way, or to pump it?—I think that, for all the purposes of the cultivation of arable land, I would take it in carts; but for grass land I would take it in water.

2891. But would it be cheaper to take a ton of soluble material in a cart for 10 miles, or to take it in mains for 10 miles?—The cheaper mode would be to take it in a cart.

2892. You stated that no town had yet utilized its sewage, and prevented it in that manner from running into a stream; is that so?—I know of no instance.

2893. Have none of those towns that you have mentioned done so?—Not one.

2894. But would there be any difficulty in doing it?—None whatever.

2895. Then all that is required is, to let people see the value of letting the sewage run over their land, and the injury of its running into the streams; is that so?—Yes, and to give the people an interest in the raw material, and to show them that it will pay to use it.

2896. You mentioned the case of a locality where one Board of Health proposed carrying out a work of this kind, and another Board who succeeded them refused to carry out this work. Do you think that, in order that this result should be achieved, you would require some authority superior to both?—Yes, unquestionably.

2897. Would you prefer to have one authority for each catchment basin, or would you prefer a central authority?—I should prefer a central authority.

2898. On what grounds should you prefer that?—I think that uniformity of action is advantageous.

2899. Do you think that any uniformity is requisite among the several catchment basins?—I think that the principles to be carried out are so much the same in all cases that uniformity would be of very much utility.

2900. Still the question of dealing with the overflow in one catchment basin cannot affect the next catchment basin?—No.

2901. Then uniformity in each catchment basin would be all that you would require?—Yes, I think it would.

2902. You spoke of the water of a farm being injured by sewage; that is for drinking purposes, is it not?—It is.

2903. But is it not a benefit to the land?—It is.

2904. You have alluded to the desirability of separating the urine from the solid part of the sewage, and you have stated that, in Huddersfield, there are large cloth manufactories; is not the urine collected to a very considerable extent for those cloth manufactories?—Yes.

2905. And that makes it valuable, does it not?—Yes.

2906. They send carts to collect it, do they not?—Yes.

2907. And they are collecting it in the towns at the present time?—They are.

2908. And they pay large sums of money for it, do they not?—Yes.

2909. Mr. *Ferrand.*] You have been asked with regard to this sewage not being valuable for arable lands; but have you ever seen it tried on arable land?—I have.

2910. How did it fail?—I consider that it failed from the great amount of injury that accrued to the growing crops by the moving about of the hose for watering.

2911. But that injury did not originate, as I understand, from the sewage itself?—No, but from the mode of application.

2912. Have you any reason to believe that it would not be very advantageous to mangel wurzel, or to turnips?—On the contrary, I believe that it would be most advantageous.

2913. Therefore, it might be applied to arable land, might it not, with as great advantage as to grass land?—Yes, under proper circumstances; it is merely to the mode of applying it that my answer as to its failure referred.

2914. Dr. *Brady.*] Alluding to these 15 acres to which you have referred as being irrigated by this sewage water, was not it the case that the sewage was very much diluted?—Yes.

2915. There was a very large quantity of water, more

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more than the actual sewage, was there not?—There was.

2916. Then, in your opinion, the fact of its being diluted, did not injure the virtue of the fructifying matter?—It altered the quantity, but not the quality.

2917. Is the fact of sewage being largely diluted, a great objection?—Not a great objection.

William J. Ffennell, Esq., called in; and Examined.

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2918. *Chairman.*] You are one of the Chief Commissioners of Fisheries, are you not?—I am Inspector of Fisheries for England, and a Commissioner of Fisheries for Scotland.

2919. Can you state to the Committee the effect of the sewage water upon the fish; is it baneful to them?—In some places, where the sewage of towns empties itself into a small quantity of water, when the waters are low, it kills a great many fish. A great deal depends upon the time at which the sewage gets into the river; if the river is in flood, and there is sufficient water to dilute it, it is not so injurious as it would otherwise be. The sewage of some towns kills the fish; but, generally speaking, the sewage of towns is not nearly so destructive to the fish as other things.

2920. Are you aware that from the sewage of towns a certain deposit takes place in a river?—A very large deposit.

2921. And does not that deposit putrify in warm weather?—Very much so, and it is very offensive.

2922. Is it so offensive as to be injurious to the fish?—Quite so.

2923. Even if you let this sewage into a river in time of flood, as soon as the water became low, would not the fish be killed?—Quite so; and another ill effect would follow. Although the sewage may not have an injurious effect while the deleterious matters are in suspension in the water, it deposits upon valuable spawning beds, and kills the ova which are deposited on those beds.

2924. Then do you consider that allowing the sewage to run into the rivers in England materially diminishes the amount of fish in England?—Very materially.

2925. If the sewage were not allowed to go into the rivers, would not the number of fish become considerably augmented, and would not that materially increase the revenue?—Yes, very much. The gas works are not so injurious as they were before the refuse from them was utilized. We have had some complaints where mischief was being done, and we have had that mischief put a stop to. The most mischievous gas works now are the small ones; the large ones sell their refuse, the gas tar, and so on; and it is used for manure, so that it is generally from the smaller gas works that we have the most trouble; they do not take the trouble to look for customers for their refuse.

2926. Are there any salmon in the Thames?—I believe there are no salmon in the Thames, except a few young fish inland, above London. There have been thousands of salmon bred, and let out, but they never go alive to the sea.

2927. Do you see any reason why the Thames should not be as well supplied with salmon as the Scotch rivers?—It only wants one thing, to purify the Thames from Richmond down to the sea. If that were done, there is no question that salmon would at once come into it.

2928. The revenue from those salmon in the Thames would be very large, would not it?—Yes; very large, comparatively with other rivers.

2929. The revenue from the small rivers in Scotland is some thousands per annum, is it not?—Yes; and it would be very much greater on the Thames. There is one river in Galway, where the proprietor receives about 5,000 *l.* a year from the fisheries at present.

2930. Is it not useless to attempt to breed salmon in the Thames, so long as the sewage of London is allowed to run into it?—Perfectly useless. It was supposed that the salmon were returning to the Thames, but no such thing occurred; I was a member of the commission appointed to inquire into the Salmon Fisheries in 1860, and we got some very interesting evidence from old fishermen then living at Richmond. It was then 35 years since the last salmon was seen there. For 14 or 15 years no grilse had returned; some salmon came up, and a corresponding number of fry went down, showing clearly that the smolts could not get through the filth alive.

2931. In former days, when cesspools were used, and when there were no water-closets, were there salmon in the Thames?—No doubt there were salmon in the Thames, though not a great quantity up to 38 years ago; but 60 years ago, according to the evidence that was taken before me on the commission I have named, there was a very considerable number.

2932. They are doing a great deal now, and going to great expense for breeding salmon in different parts, are they not?—They are going to considerable expense.

2933. Has the system of artificial propagation been found to work well?—The system has not been sufficiently tested, but the effect of protecting fish in a natural way is doing much good.

2934. But that system will be useless as long as the sewage goes into the river, will it not?—Yes; but the pollution from the mines is the great question with respect to the fish; and with respect to the pollution from the mines, I consider that it ought to be especially attended to. There is a clause in the present Fishery Act, obliging persons to prevent pollutions from the mines from running into the rivers when they can do it for a reasonable cost, which is so vague a thing that it is practically inoperative. There are several mines now in England which are voluntarily doing a great deal to obviate the injury, and a great deal can be done. In very many instances it is a most wanton thing to allow the mines to do the injury that they do. There are rivers in Wales, and some in England, where no living thing can be; horses, cows, geese, and everything of that kind are killed by the polluted water, while I have no doubt that, at a very reasonable cost, that might be all avoided.

2935. Mr. *Adderley.*] What kind of mines are you alluding to?—To lead, copper, and tin mines, which are the principal mines that are so deleterious. The Great Consols Mining Company on the

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the Tamar, in Devonshire, have voluntarily, at our suggestion, made cess pits to allow the refuse of the mines to subside, and they have deposited a large quantity of iron to precipitate the copper upon. Some lead mines have done the same; they have finally made a very large bed to filter the water through, and it comes out now pure without a cloud, from that filtering bed, and there are fish living close up to this water that comes from those great mines as healthy as possible; whereas much smaller mines, with not so much poisonous matter in them, are destroying the fish. I got an analysis made lately of some of the water from that district; and whereas the sediment in the Great Consols Mine is only two grains in a quart bottle, in the case of another mine on the same river where those beds are not employed, there are 166 grains of sediment, which could be got out as easily as in the other case, and that sediment contains most deleterious properties, which deposit in the river the poisonous matter. Many miners have told me that, in a great many instances, they would be to a great extent recouped for making those cesspits. If the Committee will allow me, I will describe one or two strong cases. The lead mines on the River Tees are on the heads of very rapid streams, which are tributaries to that river; they all have a very quick incline, and they are very careless about the number of depositing tanks; for about two miles down this stream the water is muddy; but, notwithstanding the rapidity of the stream, the deposit is so quickly made and so complete, that cows and horses that drink of the water are killed; whereas, if there were a very few depositing tanks, all that evil would be prevented; for after two miles the fish are all alive, and the cows and horses drink the water without injury; but there is a nasty white colour that goes down for 20 miles, and is injuring the river by preventing the fish feeding. The very same thing occurs, by gross negligence, on the Swale, in Yorkshire, and upon the South Tyne; and as to some of the rivers in Wales, it is terrible. Another very great and crying evil is with regard to mines that have been attempted to be worked for years, and given up as unprofitable. Pits have been sunk, and a great quantity of water gets collected in those pits, which is highly impregnated with all these deleterious matters. Then comes another party of adventurers to bore up these deserted pits, and see if anything can be done with them, and they let out all this accumulation of matter suddenly, and it destroys the fish for miles and miles. That has occurred twice in the Conway, and in some other places; and I would take the liberty of submitting, with great respect to the Committee, that this is an evil that calls for a remedy, and that the remedy is very easily obtained by compelling the miners to make these cesspools, or whatever they may be called, if necessary (in some mines it would not be necessary), and to make a bed of gravel to filter the water through. There is a department at present to attend to mines, and there are inspectors of mines, and looking at it from a practical point of view, I would suggest to the Committee, that it would be most expedient and wise to obtain legislation that would give those Inspectors of mines authority, and would require them to cause those cesspits and filtering beds to be made at every mine, and that the test should be an analysis of the waters as they come out, and that the inspectors should have the power and authority at once to institute proceedings, and to prevent miners from wantonly polluting the water.

2936. But, in your view, whose business would it be to make these depositing tanks?—Certainly the miners.

2937. But supposing that 10 or 12 people were polluting the water; how would you compel them to make those tanks?—I would not allow a man to let the water escape from his mine until he did it.

2938. Do you propose a depositing tank at each work?—At each mine.

2939. And do you think that the nuisance comes so distinctly from the different mines that an individual miner could be proceeded against?—Certainly.

2940. But is that discharge so clearly from each mine into the stream that the act of pollution might be made the ground of proceedings against an individual miner?—Quite so.

2941. What are the legal provisions in the Fishery Act to compel miners to stop such a nuisance?—The provision is, that no pollutions from mines, or anything else, shall be allowed to be discharged into the river, and that all means to prevent it, at a reasonable cost, shall be taken.

2942. Do you know of any proceedings that have been taken under that Act?—No; because individuals are afraid to commence those proceedings. If the thing amounts to 100 *l.*, or over 100 *l.*, there is an appeal, and it involves litigation. The fish belong to the public; they are everybody's and nobody's, and no individual will undertake to enter into litigation with a great mining company.

2943. Do you think that the possibility of stopping such a nuisance at a reasonable cost is a fact, and that the nuisance is so notorious that the courts would judge accordingly?—I do, but I think there is a want of some functionary on behalf of the public, to carry out that provision, and I think that that power should be given to the Inspector of Mines; you have functionaries already appointed for other things in connection with mines, and I think that it would be a most legitimate thing to require them to look after the matter. This Act has only been in force since 1861, and I believe there would have been some prosecutions under this Act, but that I have advised parties not to pull the strings too tight. I have been very diligent in speaking to miners, and I must say, that in many instances my suggestions have been most kindly and liberally received, and that some of them have now done what I think all ought to be required to do. My object was, not to disturb the amicable progress of the remedy, until we got some two or three important mines to carry it out thoroughly. I think that we have nearly done that now, and then I was proposing that when others had done it, and where it could be demonstrated that it was so practicable a thing, then people should be compelled to do it.

2944. Are you aware that there are cases where streams are polluted by gas works?—Yes.

2945. Do you know of any proceedings having been taken under the Gas Act?—Yes.

2946. Have any of those proceedings been successful?—Yes, several. There was one on the River Usk. They were about to take proceedings against the gas company, but the company

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company, on being remonstrated with, immediately stopped the objectionable discharge. A very destructive thing occurred on the River Ribble also, four or five years ago, at a place called Settle; there was a large accumulation of gas refuse, it was accidental, I believe, to a great extent, and it burst out suddenly and killed every fish, young and old, for 20 miles; hundreds and thousands of them were killed. The parties connected with the fisheries then threatened, and I believe actually did, commence an action at law, but the owners of the gas works showed that it was an accidental thing, although they admitted that it was a careless thing, and they undertook that that accumulation should never occur again, and there the thing dropped.

2947. Are the proceedings under the Gas Act more easily taken than those under the Fisheries Act?—They are.

2948. But will you point out to the Committee why the proceedings are easier in the case of the Gas Act than in the case of the Fisheries Act?—Functionaries are appointed in the first place on behalf of the towns, and there is a mode prescribed by which the proceedings are initiated; the penalties are more peremptory, and the provisions are less vague.

2949. Do you think that provisions might be made against pollution from mines as easily as against pollution from gas water?—Quite so; if the legislation were as peremptory in the case of mines, as it is in the case of gas works, because it is enacted, that they shall not let gas refuse into the water.

2950. Do you think that the provisions against the nuisance by gas water would hold as a model for provisions against the pollution by water from the mines?—I think not quite, because the same means would not be sufficient; the refuse from gas works can be retained; it can be put, for the most part, in a consolidated form, and it is a thing of so small an amount, compared to the water which is coloured from washing lead ore or copper ore, that it is quite a different matter.

2951. Without saying that one case would be as easily dealt with as the other, would the legal provisions made for taking proceedings in the one case be sufficient for the other case?—I think that the principle of the Gas Act might be adopted and carried out to a great extent; but I think that it should be varied, and that power should be given to the Inspectors of Mines to take proceedings, so that it would be a different process.

2952. Do you think that the Inspectors should prosecute?—I think that they should inspect in the first place, and call upon the miners to make a sufficient amount of those cesspools, and to make a filtering bed, if necessary; and having done that, and having pointed out to them the desirableness of it, the water coming out should be analyzed.

2953. Did you state that such a filtering bed and cesspool should be made by every miner?—They should be made by every miner. I may state, that the Devon Great Consols Company were recouped to a great extent for the additional tax which they underwent, and many miners, though not fully paid for the expense, would be partially paid in five or six years in the value of the refuse and of the waste. They do that voluntarily, to a certain extent, and although they may consider that it would not pay them to make more tanks to let it off in this state into the water, if they were compelled to carry out this depositing system fairly, they would, to a very considerable extent, be recouped for it. The Great Devon Consols Company, who were very willing about it, told me lately when I was there that they had spent about 1,500*l.* in those additional tanks for the very purpose of saving the fish, and that they did not consider it in the slightest degree unreasonable to do so, or to be compelled to do so, inasmuch as they had been recouped to a very considerable amount for the expense; and as they were a rich company, it was reasonable to expect that they should go to such an expense for the public benefit.

2954. Mr. *Ferrand.*] You have mentioned a case of gas refuse being turned into the River Ribble, and destroying the fish for 20 miles down; did not that destroy every fish in the river?—I believe so, they were taken up in basket loads.

2955. That was the reckless act of a man in violation of the law, was it not?—It was.

2956. If those gas works had been erected so as to have no communication with the Ribble would that have occurred?—It would not.

2957. Could it have occurred?—It could not; I believe that the proprietor of those gas works since that has found it his interest to allow nothing of the kind to escape if he can secure it.

2958. Is there not a penalty of 200 *l.* for turning gas refuse into a river?—Yes, I think there is.

2959. And if a gas company chose to act dishonestly, and turn out the refuse in the night time, would there be any difficulty in prosecuting them?—Gas shows very much on the water; you can see gas tar for an immense distance floating on the top of the water, so that I think the proof would be very easy in the case of gas refuse.

2960. If I were to tell you that, adjoining my property, the gas works have turned out gas refuse in the night time into the River Aire, that the mouth of the drain emptying into the river is found with the gas on it, that the grass growing on the bank below the mouth of the drain is discoloured with the gas, that I instructed my solicitor to bring an action against the Company for penalties, and that he told me that we must have positive evidence of the gas being turned out into the river before we could make a successful case, what would be your opinion?—I should think that you must prove the positive amount of injury done to you. That was not under the Gas Act, but for damages done to yourself, and, I apprehend, although I am not a lawyer, that under the Gas Act a prosecution would have been sustained by those appearances, which would satisfy a magistrate or a jury, that the gas refuse had been turned out into the river.

2961. Do you not think that it is necessary for the preservation of the fish, and for the prevention of the pouring of gas refuse into the rivers, that there should be a law forbidding any connecting drain between a river or stream which is filled with fish and gas works?—Unquestionably.

2962. Do you see any harm in a clause being inserted in an Act of Parliament, allowing the entry of any person into gas works to examine if there is any such connecting drain?—No; I should think it a very warrantable thing, if it were shown that there was cause to suspect it.

2963. Are you aware of any instances where fishing is injured by manufacturers turning the refuse of their works into the river?—Yes, to a fearful extent.

2964. Is it not your opinion that, generally speaking, the manufacturers are totally indifferent to the injury which they do to their neighbours?—In very many instances they have been so, but in very many instances, since I have become connected with the fisheries, they have done a great deal to mitigate the evil, although not nearly as much as they should have done.

2965. You are speaking now of the Salmon Fisheries?—I am.

2966. Are you not aware that there are a great many valuable trout streams in England?—Yes; and some of them are fearfully destroyed.

2967. Knowing so many instances of manufacturers having shown a good spirit, and desiring to remedy the evils which you have referred to, are you aware whether they have been put to any serious expense in doing that?—None, to a serious extent. There is one manufacture to which I would call the attention of the Committee, which is the manufacture of paper, and that is a most fatal thing to fish, if the manufacturer is careless or wanton with regard to the refuse from the manufactory; but they can easily collect that refuse, as it will consolidate. I met, about a year ago, a gentleman who has a large paper manufactory on the river Swale, in Yorkshire, where the fish have been poisoned by the refuse from his mills, and he admitted that the refuse from his paper mills, which was deleterious, could all be consolidated in a sort of paste, containing chloride of lime, and that the whole of it would only amount to about a ton and a half a week. I said to him, "Would it not be reasonable to compel you to cart it away once a week into the country?—He admitted it, and I believe he has done so since.

2968. You have alluded to the crust from the refuse of those towns remaining in the beds of streams; will not that crust remain on the bed of a small stream to a greater extent than on the bed of a river?—Quite so, and it is very fatal.

2969. Do not the trout resort in the autumn to all those small streams for the purpose of depositing their spawn?—Yes.

2970. And that being the case, does not the crust at the bottom of those small streams to which you have alluded destroy the spawn?—It destroys all that part of the river for the production of the fish, and renders it totally fruitless.

2971. Although you might have half a dozen or a dozen manufacturers who were inclined to aid and assist in the preservation of the fish, still, if you have one manufacturer on one of those small streams who is regardless of the interests of his neighbours, and says that he will turn his refuse in without any desire to accommodate the owner of the stream, could he not himself destroy that stream as a spawning stream or a fishing stream?—Quite so; and in the case of mines it is just the same. There is another case with which I am acquainted, where there were a great many miners, and they had all, except one, done what was necessary, and sent their water out perfectly harmless; one miner would not do it, and he is destroying the whole of the river.

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2972. Is not that one miner violating the law notoriously in the neighbourhood?—Quite so.

2973. Do you consider that it would be unfair to apply to Parliament for a more stringent law to prevent that man from so injuring his neighbours?—Certainly; above all things I should recommend that there should be public functionaries to do it. I should not like to mention the name, but I know a case where a stream is injured by a person who possesses considerable power and ascendancy in the neighbourhood, and one could hardly expect that any individual person would like to attack such a man as that.

2974. The washings from the lead mines passing through the tanks, would cause the poisonous matter to be stopped on its course to the river; if that refuse from the lead mines were passed through filtering tanks, would not all the poisonous matter be prevented from entering the rivers?—I believe nearly the whole.

2975. You recommend the last tank to be filled with sand, do you not?—In some cases it would not be necessary; it is easily ascertained what the deposit is composed of; in some cases it will all be deposited, and in others it requires to be filtered.

2976. What are the manufactories with which you are acquainted, which injure the water?—Those that I have looked closest after, and that are doing the most mischief, are, I think, the printing and dyeing works.

2977. Are they worked by steam power?—Some of them are, and some are worked by water.

2978. Are you aware that the engine ashes are used in some places for the purpose of filtering?—No, I am not; but with respect to the chemicals that are used in those printing works, I know that they use a good deal of arsenic; they use a strong solution of arsenic, and they put those cotton things into the solution to make the colours fast, as they term it, and in doing that the cotton things do not absorb all the arsenic; many of them let out into the river the refuse of this poisonous matter, when they might retain it for a while, and it will kill every fish for a long distance.

2979. Supposing that the water passed through large tanks filled with engine ashes, are you of opinion that it would be filtered sufficiently to destroy the injurious effect of the poisonous matter?—I will not venture upon an opinion as to that, because it requires some scientific knowledge. I may mention to you the particular case of the Calder, which is a tributary to the Ribble. There are a great many printing and dye manufactories on the Calder, and within the last 15 or 16 years, every fish in the river has been killed; it abounded in salmon before that. The Fishing Association there have remonstrated with those manufacturers, and there are a great many people who have mitigated the evil so far voluntarily, that a lot of fish went up into the Calder last year. There, where there was a will there was a way, and a great deal of the evil was overcome.

2980. Did you see a better spirit in the country with regard to the preservation of fish among the manufacturers themselves?—Very much so; the fact is, that there was a total neglect of it until very recently.

2981. I understand you to state that the greatest portion of the damage that has come under your notice in this country, has been pro-

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duced by gross negligence; is that so?—A great deal of it has.

2982. Mr. *Hibbert.*] You have named several streams as having been injured by the mines; are there any others that you can call to mind?—Yes, there is a very long list indeed. There are some rivers which old men remember as abounding in salmon and trout, in which there is no living thing left now. There are the two rivers that run into Aberystwith, the Rheidol and Ystwyth; no living things are in those rivers. If a flood overflows the grass, and a cow or a horse eats the grass, it is killed, because the water is so strongly impregnated with poisonous matter. The people in the mines go to a great expense in conveying the water for miles, to effect this washing which I have referred to, and if they laid out one-twentieth part of the expense to prevent this injurious effect to the water, they could prevent it.

2983. Are you aware that the fish in Coniston Lake have been injured in the same way?—I have heard several reports of it.

2984. Can you get rid of that milky suspension in water in the manner which you have described?—A great deal of it might be got rid of by the subsiding process in the tanks, and a great deal of that is really clay slate, that is not poisonous; the fish cannot feed on account of it, and every atom of that would be got rid of. On the Tees, for a great many miles down, the water is white, and the fish will not rise, but all the deleterious substances are deposited before they reach the part where the water is white. Tuesday morning is the morning the fishermen look out for, because, by reason of the cessation on Sunday, the water gets clear, and they have very good fishing.

2985. You have stated that private parties are almost afraid to prosecute in those instances of pollution of streams which you have mentioned; have you known any instances where the Fishery Association have prosecuted?—The Fishing Associations, in many instances, have abstained at my desire. My object was to see established two or three *bonâ fide* cases to show whether it could be done. But I am quite satisfied, from the way in which the provisions in the Fishery Act were framed, that there would be a great deal of difficulty, and I think that nothing would be more legitimate than to authorise the Inspectors of Mines to do it. Here is a letter, dated the 28th of May 1864: "I see by the papers that a Bill is shortly to be laid before the House, to amend 'The Salmon Fisheries Act, 1861,' I trust you will be able to get introduced a clause, rendering the filtering of the refuse water from mines compulsory. Without such a clause I feel sure our once beautiful rivers must still continue as at present, filthy streams, and quite useless as salmon streams. At present not only are all fish destroyed by the mineral poison, but the herbage on the banks is also destroyed. Surely it cannot long continue that the interests of a comparative small body should entirely do away with and nullify the rights and privileges of the public. A clause, such as I before mentioned, would, I am sure, work well, and the costs to the miners be very trifling. In fact, in many mines, the filtration would pay its own expenses, as you are aware. I am, my dear sir, yours truly, Henry Michelmore, Honorary Secretary, River Teign Preservation and Fishery Association."

2986. *Chairman.*] You have stated that some authority was required to prevent miners from allowing polluted water to run into streams, and that under the Fisheries Act, it was forbidden to allow any polluted water of any kind, or sort, to flow into the streams?—Yes.

2987. You have also stated, that sewage was utterly poisonous to fish; is that so?—Where the sewage is of a large amount it is poisonous.

2988. You stated, that under the Fishery Act, no proceedings were taken, because private parties did not like to incur the expenses of prosecution?—They are afraid.

2989. Do you think that it should not be left to private energy, but that a public department should undertake this duty?—Certainly; and it may be right for me to mention, that the Fishery Act restricts the amount of expense, where you could recover in a summary way a penalty of 200 *l.* *See* 24 & 25 Vict. c. 109, s. 6.

2990. Are not certain functionaries appointed to prosecute under the Gas Act?—Yes, the Town Commissioners, or some such body.

2991. Do not you consider that it ought to be the duty of some functionary to prosecute in the case of the destruction of fish?—Most certainly.

2992. It has been proved in evidence, and it stands to reason, that if one town stops the sewage from running into a stream, and another town allows it to run into that stream, the pollution remains as much as if both towns allowed the sewage to run into the stream?—It is not quite equal, but it is very bad.

2993. Then, are you of opinion that there should be one authority over the whole catchment basin?—Certainly.

2994. Are you of opinion that there should be a separate authority in the case of each catchment basin, or that there should be one central authority in London?—There should be a central authority in London, but I do not think that you could work without deputies in the districts. Some catchment basins are so large that they must require two functionaries, such as the Severn or the Trent, whereas in other districts one functionary would be sufficient for each, or perhaps for two or more basins.

2995. But still there should be a unity of action and one authority throughout the catchment basin?—Certainly.

2996. And you also consider that there should be powers to prevent any pollution whatever from running into the rivers?—Certainly.

2997. Mr. *Ferrand.*] If the Inspector of Fisheries were to prosecute, who should pay the expense incurred?—The Inspectors of Fisheries have no power to prosecute at all.

2998. But were you not suggesting that fresh power should be given?—To the Inspectors of Mines; I would not at all give it to the Inspectors of Fisheries, although the damage to the fisheries is of very great extent. The Inspector of Fisheries might report to other functionaries.

2999. Then, if the Inspector of Mines is to prosecute, who is to pay the expenses of the prosecution?—My opinion is, that the State ought to pay, because it is so public a matter, pollutions of rivers affecting the community at large.

3000. But, supposing that a man rents a salmon fishery to the extent of 5,000 *l.* a-year, and some person injures that fishery by sending mineral water into it, do you propose that the tax payers should pay the expense of the action in that case?—There is no such thing as a large salmon fishery in England at this time, and every man who can provide a boat and a fishing net, has a common-law right to fish in many existing open waters. There are over 300 men obtaining their livelihood by salmon fishing on the Dee; 50 or 60 on the Torridge, and some hundreds in the estuary of the Severn; and I trust, before many years are over, to see the frieze-coated fishermen exercising their common-law right of salmon fishing to a much greater number in many open waters.

3001. Then your opinion as an Inspector of Fisheries is this, that the salmon fisheries of England will, in a very few years, if properly preserved, become so valuable that the State itself ought to step in to protect them?—In matters of that kind, which are so entirely public, I think it should do so. There are 300 men representing 300 families, gaining their livelihood by fishing for salmon in the estuary of the Dee, for instance. All the rest of the river is divided into very small interests amongst the proprietors of the fresh-water streams.

3002. You have also stated that trout fisheries are very valuable?—Yes; but they are different in this respect, that they are private property, inasmuch as the trout do not migrate to open tidal waters.

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3003. But are you of opinion that the trout fisheries are not sufficiently protected by law at the present time?—Yes; and if the object of the State is to protect salmon fisheries, you also protect the trout fisheries.

3004. In the case of pollution by the refuse of gas works, you state that the Town Commissioners are the persons authorised to prosecute?—I think so, but I will not say exactly who the appointed persons are.

3005. Supposing that the Town Commissioners are the persons so authorised, are you not aware that very often the gas works of a town which belong to the corporation, turn the gas refuse into the river?—I am quite aware of that; a case of that kind arose in this very gas work on the river Usk, to which I alluded.

3006. Therefore, it is your opinion also, is it not, that the law with regard to gas works requires alteration?—Yes; so far as extending the power to prosecute.

3007. With regard to prosecutions under the Salmon Fisheries Act, do you see any objection to the chief constable of the county prosecuting?—Certainly not, he is a man who ought to protect the public interests, and a great portion of the salmon fisheries of this country are public property in the broadest sense, and available to the industrious humble man.

Jovis, 9° *die Junii*, 1864.

MEMBERS PRESENT:

Mr. Adderley.	Mr. North.
Mr. Cowper.	Sir William Russell.
Mr. Ferrand.	Sir Frederic Smith.
Mr. Leader.	Mr. Tite.
Lord Robert Montagu.	

LORD ROBERT MONTAGU, IN THE CHAIR.

SAMUEL H. GAEL, Esq., called in; and Examined.

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3008. *Chairman.*] YOU are a Barrister, are you not?—I am.

3009. Was it you who prepared the Metropolis Sewer Consolidation Bill in the year 1848?—The original draft of the Bill I did.

3010. Did you also prepare other Bills relating to the public health?—One of the Nuisance Removal Bills I prepared; and I prepared upon that occasion, upon the instruction of the Sanitary and Sewer Commissions of that day, charts of all the Sewer Acts and all the Paving Acts for London, in number nearly 200.

3011. Will you explain what you mean by "charts"?—Some of the sewer charts were printed, and one of them I will hand into the Committee, containing the exhibition of the original law. (*The same was delivered in.—* Vide *Appendix.*) I think it will be instructive to the Committee if they wish to follow the progress of the law. That chart was for the Tower Hamlets, which was the most simple Commission at that time in force. There were about six Commissions; one for Westminster and part of Middlesex, another for Southwark and parts of Surrey and Kent, another for Holborn and Finsbury, another for the Tower Hamlets, excepting St. Katherine's, and another for Poplar. Those were all consolidated by the Metropolitan Sewers Consolidation Act of 1848, and, for the purposes of that consolidation, all the Acts then in existence were reduced to this uniform system of exhibition by means of charts. They were all analysed, and their contents put under certain pre-ordained heads, so as to admit of easy comparison by mere juxta-position.

3012. Did you collect a great deal of information regarding Statutes and cases which would show the progress and growth of the Sewer Law?—In the course of that examination I had to make so minute an analysis of the contents of all those Statutes, and of the several cases bearing upon them, that I probably learned as much about it as anybody could well learn at the time.

3013. Were those Commissioners of Sewers of very ancient date?—Very; they go back to the Statutes of Henry VI. The existing Statute which is still in force is in the time of Henry VIII. That is the origin of the foundation of sewer jurisdiction, properly so called. The progress that it has made in London, beginning with the Commissions issued under the Act of Henry VIII., is the subject of exposition in those charts.

3014. Were they originally instituted then under Henry VI.?—Yes.

3015. What were their duties?—Their duties were mainly intended to repress the outrageous overflowing of the sea and other surface waters.

3016. They were to prevent the sea from flowing in over the land?—Partly so, and partly to keep the channels to and from the sea open and navigable. Those appear to have been their principal and almost their only duties in the original constitution and intention of the Sewer Law, and that Statute, with that design, has been followed out by numerous others that bring it down to the present reign.

3017. There are then a series of Statutes still in existence relating to the proper purposes of sewers?—Yes, there are; they consist of 23 Henry 8, c. 5, the "Bill of Sewers," as it is called, which is exhibited in the first chart that I handed in; the 3 & 4 Edward 6, c. 8.

3018. Mr. *Tite.*] Have those Acts all the force of law?—No; they are worked by means of Commissions issued by the Crown in particular districts creating jurisdiction where necessity, as the statutes say, arises.

3019. *Chairman.*] Will you continue your enumeration?—13 Elizabeth, c. 9; 7 Anne, c. 10; 3 & 4 William 4, c. 22; 4 & 5 Victoria, c. 45; and 12 & 13 Victoria, c. 50, and the Land Drainage Act, 1861.

3020. Which was the Statute that issued the Commission for the City of London?—The 23 Henry 8.

3021. Is that the law which now controls the management of the sewers of the City?—Not of the London sewers; they have a City of London Act, and there is a Metropolitan Act.

3022. Were there distinct Commissions issued for different districts, such as Holborn, Finsbury, and so on?—Yes, for the City of London, Holborn and Finsbury, Westminster and part of Middlesex, Southwark and some parts adjacent, the Tower Hamlets, Poplar, and Greenwich.

3023. That was under the Act of Henry VIII., was it?—Yes.

3024. Did the Act of the third of James I. extend the sewer jurisdiction?—Yes, the Act of the third of James I was a remarkable Act, because it extended the jurisdiction of the Commissioners of Sewers to gutters, streams, and water-courses, within the limits of two miles from the City of London, although the water did not usually ebb or flow in them, and there was no usual passage of boats therein.

3025. Then it extended beyond the original meaning of the word "sewer"?—I think it clearly extended the meaning of the word "sewer."

3026. The word "sewer," related originally to water-ways which were navigable?—Yes; in which the tide ebbed and flowed, or in which there was the usual passage of boats.

3027. But this Act of James I. extended that meaning to water-courses not navigable?—To gutters, streams, and water-courses, which would include all ordinary cases.

3028. Then has not the law been strained to make it apply to that modern meaning of the word "sewer"?—Some want, no doubt, must have called for that Act; that want was to apply the sewer jurisdiction to what it had not been considered applicable before, and hence that Act.

3029. Was the straining of the law carried still further by means of Private Acts?—The whole series of the Metropolitan Sewer Acts under the separate commissions are extensions from time to time of their jurisdiction, for the purposes of dealing with town sewerage.

3030. Was not there a Commission by a Private Act for Holborn and Finsbury?—Holborn and Finsbury got a private Act, particularly for the part called Finsbury.

3031. At what time was that?—The 18 Geo. 3, c. 66.

3032. That Act was amended still later, was it not?—Yes; by the 54 Geo. 3, c. 219.

3033. Was not there a private Act also for Westminster and part of Middlesex to Fulham?—Several for Westminster, beginning at the 47 Geo. 3, sess. 1, c. 7.

3034. What was the effect of that Act; did it not empower the Commissioners to make new sewers?—Yes, that empowered the Commissioners to make new sewers.

3035. And it also required that notice should be given to the Commissioners of any private persons who intended to make sewers?—Yes, it also required that notice should be given to the Commissioners in such cases. It would appear by that (and a doubt was stated about it by the learned lawyers of the day), that the jurisdiction and authority of the Commissioners to order new sewers had been discussed originally; the Sewer Commissioners seemed to have taken into their control existing works, and not as a matter of course to have undertaken new works. Sewerage was considered to be a landlord's duty, and the tax was a landlord's tax; it was not an annual tax, but casual, as the necessity arose. Therefore, there were great doubts entertained whether the jurisdiction of sewers extended to the making of new works, which this Act was intended to remove.

3036. Then that being the case, this Act was passed in order to enable the Commissioners of Westminster to make new sewers?—Certainly, and to require the builders and others who make new sewers, which, when made, they called upon the Commissioners to take care of, to give previous notice to the Commissioners, in order that they might be properly made.

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3037. Will you name the other Acts?—The 52 Geo. 3, c. 48, the 7 & 8 Geo. 4, c. 23, the 4 & 5 Will. 4, c. 96 (that related to a large new sewer made through Hyde Park, to divert soil drainage from Westbourn Brook, *i. e.*, the Serpentine), and the 10 & 11 Vict. c. 70; that latter Act was got by the Commissioners after the great discussion about the sewers, and the shortcomings of the Sewer Commissioners; though they had no time, in fact, to make it operative, because the Metropolitan Consolidation Act came the next year; but they got it with a view to carry out what was called sanitary progress.

3038. Were there not also private Acts passed for parts of Surrey and Kent, called the Surrey and Kent District, to enable the Commissioners of that district to make new sewers?—The 49 Geo. 3, c. 183, and 50 Geo. 3, c. 144, enabled them to make new sewers, and that was extended by the 53 Geo. 3, c. 79. They also obtained an Act, under the pressure of sanitary progress, to set their drains in order, in the year 1847; that was the 10 & 11 Vict. c. 257.

3039. That Act also charged the owners with the expenses of new sewers, did it not?—I think it did. Those were the Acts that were reduced to the charts. That Act of Surrey and Kent gives the Commissioners authority to make new sewers; that was the 49 Geo. 3, c. 144.

3040. But does not the 10 & 11 Vict. c. 257, charge owners with the expenses of new sewers?—Yes, and some of the earlier Acts do in that district.

3041. Did you not state that originally landlords had to make the sewers entirely at their own expense?—It seems to have been the practice for the landlords or the builders to make the sewers, and then call upon the Commissioners to take the care of them, whence those provisions requiring notice before hand.

3042. It appears, then, that there are three different classifications of sewers under that one head?—There are three noticed under these Acts of Parliament. Those are, first, the public sewers, that is, the main sewers; secondly, the common sewers, which are common to the streets and several collections of houses; and, thirdly, drains.

3043. Are those the private house drains?—Those are the private house drains. Those later Acts of 1847 gave the Commissioners jurisdiction over house drains, which they had not before, except incidentally as to making conditions of entering.

3044. Then the public or main sewers are those which have outlets in rivers or streams, or into the sea, are they not?—The public sewers would be such as they happened to find at the time adequate to the discharge of their superfluous water.

3045. In fact, they are old water-courses?—Yes, old bourns or water-courses.

3046. Those were ultimately covered over?—Yes, those were ultimately covered over, but not always, by the Commissioners of Sewers; as, for instance, the great bourn or water-course, called the River Fleet, was covered over by the Corporation of London, who erected Fleet Market upon the site of it.

3047. That was in the time of George II., was it not?—That was in the time of George II. They covered over the Fleet Ditch from Fleet Bridge, at the end of Fleet-street, to Holborn Bridge.

3048. What was the reason assigned in the 6 Geo.

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6 Geo. 2, c. 22, for empowering the Corporation of London to cover that ditch?—It was originally intended to be a navigable channel, and was so required by the City of London Rebuilding Act; and the Act of George II. recites that the channel was found to be of no convenience or benefit to navigation, but that it was filled and choked up with mud, and that it had become a grievous and dangerous nuisance. The Act, therefore, enabled the Corporation of London to cover it over, leaving proper drains.

3049. You stated that lawyers hold that no new public or main sewer could be made, did you not?—That seemed to have been the opinion of several very learned lawyers, and, amongst others, of Sir Edward Coke; and it is also noticed, in the First Report of the Health of Towns Commission, in the year 1847, as being a reading of the original Sewer Acts.

3050. Now, with regard to the second class; that is to say, common or street sewers; the Fleet-street Sewer was one of the earliest of those, was it not?—The Fleet-street Sewer is mentioned as a very early sewer. I do not know the origin of that, but my information is collected from law books; it might be sought historically, no doubt, but we do not find it mentioned in any Act of Parliament.

3051. Then there was the Charing Cross Sewer, running down to Whitehall Palace, was there not?—That is mentioned in the 13 & 14 Charles II.

3052. It was made by the Commissioners of Sewers, was it not?—It was made by the Commissioners of Sewers, but it was declared to be a sewer within the jurisdiction of the Sewer Commissioners by another Statute.

3053. The Paving Commissioners made new sewers to some streets, did they not?—They appear, under these Paving Acts, to have made a great many of the sewers, and to have obtained powers of rating for making them.

3054. When those sewers were made by the Paving Commissioners, were they not put under the jurisdiction of the Commissioners of Sewers in King William the Third's reign?—Several of them which were made under one of the earliest of those Acts, viz., the 13th & 14th of Charles II, were declared to be within the jurisdiction of the Commissioners of Sewers, by the 2d & 3d of Will. and Mary, s. 2, c. 8; that would be about 1690.

3055. By whom was the sewer in Chancery-lane made, in the time of Charles II?—We have rather an amusing account of that in the life of Lord Keeper Guildford, who being a very shrewd lawyer, and understanding things not generally understood, caused it to be made by the Commissioners of Sewers. The account of it as given in his life is rather amusing, and shows exactly the state of the Chancery-lane houses, so far as regards the accommodation of drainage at that day. It says, "His Lordship procured to be done another good work, which exceedingly improved the dwellings in all Chancery-lane, from Jackanapes-alley down to Fleet-street. He found in his house a small well, in the cellar into which all the draining of the house was received, and when it was full, a pump went to work to clear it into the open kennel of the street. But during this pumping the stench was intolerable, and offended, not only his Lordship, but all the houses in the street, and also passengers that passed to and fro in it. And other houses there which had any cellars, were obnoxious to the same inconveniences. His Lordship proposed to them to join in the charge of making a drain or sewer all along the street, deep enough to discharge into the grand common sewer in Fleet-street. The inhabitants would not join, alleging danger to their houses, and other frivolous matters, and thereupon his Lordship applied to the Commissioners of Sewers and obtained a decree, by virtue of which it was done, whether they would or no, and the charge paid by a contribution levied upon them, and then they thanked his Lordship as for singular good done them."

3056. Had not those who built new streets and made the sewers into them to apply to the Commissioners of Sewers for leave to open the main drains?—To open drains into the sewers they had to apply to the Commissioners.

3057. To open the public sewers to receive the street sewers was not that the case?—Yes.

3058. With regard to what you stated of Lord Keeper Guildford, very few houses had sewers in those days?—Very few, I should suppose, from that.

3059. Then, how were the houses drained?—The drainage would appear to have been from gutters into the street kennel, when there was no basement, the kennel running in the middle of the street.

3060. The drains ran from the ground floor across the street into the middle, and then it flowed down the middle of the street without being covered over; was that the case?—Yes.

3061. Then, where did it flow thence?—It went into the natural water-courses, as you might call them; the Fleet Ditch, and so on.

3062. Then, those few houses that had cellars, had a well such as Lord Keeper Guildford's house had?—Yes. In the Metropolitan Sanitary Commissioner's First Report in 1848, I find a similar description of a great many streets in Westminster; that the people there, in order to get rid of offensive liquids, had to pump them up from the basement into the middle of the street, or into the sewers. That was in 1848. In describing the state of similar streets in Westminster, the Report says that they were obliged to pump up the contents of those dry wells, as they were called, into the sewers. There were sewers there, but they were not deep enough to drain the cellars.

3063. In former times they had always to do so, had they not?—They had always to do so, until the deep sewers were put in.

3064. Have they to do that in any part of London now?—I do not know.

3065. Did they not discourage the making of drains into street sewers?—They seem to have exercised a sort of precaution about it, which no doubt operated to some extent as a prohibition.

3066. And it also involved heavy charges, did it not?—Yes; and the notice, and that sort of thing.

3067. Was that the case down to a very recent date?—Yes; to a very recent date.

3068. So that till a very recent date every possible restriction was put upon making house drains?—I cannot say that every possible restriction was put upon making house drains, but no doubt those expenses and restrictions, to a great extent, amounted to a prohibition.

3069. Was that for fear persons should make holes in the sewers?—Yes, partly so; and also from the desire to keep the sewers to carry off superfluous

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superfluous water, rather than to carry off solid matter. Those wells in the cellars were not intended to carry off solid matter such as the sewers now receive; but to carry off the fluids used in the house; the rain water, I presume, they would not have taken, but the waste water of the kitchens, and sculleries, and so on.

3070. If they discouraged the making of drains, and those wells were not intended to hold solid matter, what was the rule of common law concerning privies, at that time?—The common law, as rather coarsely expressed by one very learned and able judge was, that every man should keep his dirt to himself.

3071. Who was that judge? — Lord Chief Justice Holt.

3072. Then had they cesspools?—They had cesspools in most places.

3073. It was only the overflow that could possibly run into the sewers, was it?—Exactly.

3074. Was there any communication between those cesspools and the sewers?—I do not know that there would be any prohibition of the Commissioners other than their restrictive conditions. I am not aware of any, excepting when the subsequent statutes came into force, such as the 2 & 3 of William and Mary, which prohibited the use of the street for the purposes of discharge.

3075. Does not Mr. Drew, Surveyor of Sewers, state that there was no communication allowed between the cesspools and the street sewers?—I think he does, in the Report of 1834, to the House of Commons; that was before any discussion as to sanitary subjects.

3076. Was the privy to communicate directly with the sewer?—Not directly; the privy was to communicate by means of the cesspool.

3077. Then what was done with all this solid matter which flowed into the cesspools?—That had to be removed by the hand, and by subsequent Acts contrivances were introduced; these were arrangements like the *vidange* of Paris.

3078. When water-closets were introduced in the year 1844, or thereabouts, then builders began to dispense with those privies and cesspools, and it was not till then that they began to flush into the sewers, is not that the case?—I cannot state any particular date for the introduction of water-closets, but the progress has been going on, and it had been continually increasing till 1847, when those sewers were all put under the same Commissioners; and then, upon the sanitary discussions, the Commissioners gave orders to the surveyors to have the cesspools emptied generally into the sewers.

3079. But if I understand you rightly, the law had not been changed, so that it was illegal to flush into the sewers, was it not?—I really do not know whether you could say what was legal or what was illegal as to this matter. So far as regarded the original intention of sewer law, undoubtedly it was quite a foreign arrangement.

3080. It was not intended by the common law that the cesspool matter should run into the sewer?—I think clearly not; because the present exposition of the common law in all those recent cases in which local Boards have been compelled to discontinue discharging sewers into rivers is based upon the notion that it is not lawful to pollute streams with sewage matter.

3081. It is only quite lately, is it not, namely, since the introduction of water-closets, that builders have begun to flush the cesspool matter into the sewers?—I think that that must be the only means, that they could go direct into the sewers.

3082. Did that induce them to take this action, which is illegal according to common law?—They, having got the authority of the Commissioners of Sewers to connect their drains with the sewers, threw all responsibility then upon the Commissioners of Sewers.

3083. It was the Commissioners, then, who acted thus illegally?—Yes.

3084. In many houses they had no outlet or access to cesspools; what was done in that case with regard to the impurities of the house?—There is an Act of the 2 & 3 William and Mary, session 2, c. 8, which has already been referred to, which prescribed that there should be a service of scavengers to go round.

3085. And the scavenger came round at stated periods with his dung-pots and carts, did he not?—Yes, with all contrivances for the purpose of removing the matter.

3086. Did he do that every day?—Every day, excepting Sundays.

3087. Were those pots made of metal?—No doubt they were rude contrivances for the same purpose, and of the same description as the improved contrivances that are now in use in some places.

3088. Were they not very much like those that are used in Paris at the present time?—Very much, I should think.

3089. When they were removed by those scavengers, where was this matter put?—This Act of Parliament gave authority to procure what are called laystalls; that is, places of deposit for laying of refuse.

3090. Did the scavengers carry all the refuse away in their carts, and deposit it in laystalls?—Yes, they deposited it in laystalls, from which places it was removed in the return country carts which had brought in vegetables and produce to London.

3091. At that time did not all the contents of the cesspools find their way on to the land?—There must have been always cases in which the water-courses were made use of in the way they are now, to some extent; but, as a system, that was the system which the Legislature then thought fit to adopt.

3092. Did not 13 & 14 Charles II., which has been already mentioned, empower the Commissioners to use wharves for the purpose of shipping off this manure?—Yes, with the same view.

3093. Was there not a later Act which prevented the sewage from being cast into the highway?—That is the present law, the General Highway Act; 5 & 6 William IV. prevented that, and also the General Turnpike Act.

3094. The outlets of the public sewers were originally the outlets of the original water-courses, were they not?—Yes, they seem to have made use of the water-courses along the whole length.

3095. Then the only change that occurred was the change in the quality of the fluid?—And subsequently arching them over, because when they were arched over of course the contents were discharged in a state but slightly altered, very different from what they would have been if they had run in the natural channel upon the ground; they then would have been partly absorbed by coarse vegetation.

3096. Then it would not be far wrong if it was stated that the sewage never entered the river until after the introduction of water-closets into

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the houses?—I think, as a general system, it was not contemplated that it should at that time.

3097. Should we be far wrong in stating that as a fact?—The object of the Legislature at that date was to provide other means of disposing of the sewage.

3098. Do you mean by putting it over the land?—Yes.

3099. And since the water-closets have been introduced, by a certain illegal action of the Commissioners of Sewers, the land has been robbed and the rivers polluted; is that the case?—They do not appear to have acted legally, but they have obeyed a movement which began independently of them, and which they had evidently very little promoted themselves, and they went on acting as they considered, I suppose, legally, and the consequences were as you describe.

3100. Is not that contrary to the provisions of common law?—Certainly; and I think that as the law is expounded at the present day, and always has been, the rivers were not to be polluted.

3101. By the common law it is unlawful to pollute the water of rivers, either public or private; is not that the case?—I think it may be so stated, if it produce a public injury or a private damage.

3102. Or if it be a nuisance?—If it be a nuisance to the public, or that produces a private damage.

3103. Will you explain what you mean by the word "nuisance," or "grievance," and what the remedies are?—It can be best explained, I think, by taking those cases that have occurred. There are cases reported in the law books in which the steeping of skins, producing noxious airs, and contamination of water has been prevented by indictment, which was a public remedy.

3104. What instance of that is there?—That was the case of King *versus* Papineau; that was for steeping skins in the Wandle River, which was very important to be kept pure, as it was used for bleaching.

3105. Was the indictment based on the fact that the air in the adjacent highway was polluted?—That was introduced into it; that is the case which was a remedy for a public grievance.

3106. Is there not another remedy called "abatement"?—That would be where a private person, being injured by a process, might take upon himself to redress the injury by stopping the nuisance?—There are other means of remedy; there is a criminal information, which was what Mr. Adderley had recourse to; he had an information by the Attorney General; that went upon the notion of a public grievance.

3107. He had an information because it was a nuisance, had he not?—Yes; and in the Luton case they proceeded, I think, also on the information of the Attorney General.

3108. Had not the old Court Leet an extensive jurisdiction to inquire into the nuisances?—The Court Leet seems to have been the general conservator of small streams in ancient times. I have seen many instances in which they have exercised a very strict inquest upon the condition of streams.

3109. They could only impose a fine, could they?—They could only impose a fine.

3110. What were the courts in which these different processes of indictment and information took place?—The ordinary indictment was before a grand jury in a criminal court, and the information was before the Court of Chancery, or it might be in any court, I believe.

3111. Was not the Wandle at one time used for bleaching?—Yes; it was a pure water river.

3112. Then, gas refuse was turned into it?—There is a case of turning gas refuse into the Thames, of which the Corporation of London were then the sole conservators, and they prosecuted the gas company.

3113. For what reason was that prosecution instituted?—Because the refuse destroyed the fish.

3114. Under what Act was that?—Under the common law; that was about 1820 or 1821.

3115. Will you mention the name of that case?—That is The King, on the Relation of the City of London, the Conservators of the River Thames, *against* Munro and Evans.

3116. Was that tried at the Croydon Assizes, in 1831?—It was; it is noticed in Paris, and Fonblanque's "Medical Jurisprudence."

3117. For an information, the nuisance must be public, must it not?—It might be private, but for the criminal jurisdictions it must be public.

3118. It must be a common nuisance, in fact?—Yes.

3119. Would corrupting or polluting the water be regarded as a common nuisance?—I think it would.

3120. Whether it was by flax lying in water or lime, or any other instances?—Those were the common instances in the old days. Steeping flax is a very common way of contaminating the water.

3121. Is lime also mentioned?—Yes; that is regarded as a nuisance.

3122. What modifications of the Law of Nuisance were there?—By statute, there were modifications.

3123. Were there not some maxims?—Yes; those have had a very considerable influence. The maxim, *De minimis non curat lex*, has exercised a very considerable influence, and "The balance of convenience over inconvenience in particular cases," which is not now recognised. Practically, there has always been a very great difficulty in fixing upon the right party, so that where several perpetrators of a nuisance contributed to the nuisance, they could not be united for the purposes of prosecution, but you had to take each in his individuality; so that when A. was indicted for a nuisance to which B. was also contributory, he and his advocates would dwell before the jury upon the large contribution that B. made, and that his was comparatively little, and so *de minimis non curat lex*. They shuffled it off thus from one to the other in a great many cases.

3124. With regard to the maxim that you have mentioned, *de minimis non curat lex*, is that because the nuisance may be considered so small a nuisance to the public that it would not support an indictment?—I think it must be, and the injury being so small to the public, the inconvenience to individuals from the multiplicity of actions would be greater.

3125. Can you give any instance of that. Was there not a trial about a harbour which was supposed to be injured?—That is the case of The King *versus* Tindal, which is reported in 6th Adolphus & Ellis, p. 143. The same thing also frequently arises in questions about abstracting water, and there is a series of cases about that.

3126. Under this species of relaxation, would you place the nuisance occasioned by the contributions of persons to river pollution?—I think I would; each case, as I said before, being taken upon its individuality, and the combined effect not being the subject of prosecution against the parties producing it as a whole.

3127. The individual effect being very small in comparison to the great amount of pollution produced?—Yes.

3128. Then is there not the second maxim with regard to the convenience of the nuisance being greater than the mischief occasioned?—Yes; that appears to have had a very long reign in the law, and possibly it exists now to some extent. The common illustration of that was rather jocose; it is taken from an old law book, which says, in effect, that the tallow-chandlers would not be considered a nuisance, because, in the jargon of the law, "*le needfulness de eux dispensera ove le noisomeness dell smell;*" that is to say, there would be more public advantage from the manufacture than disadvantage from the nuisance.

3129. Was there not another case with regard to a pier that was erected on the Tyne, and which prejudiced the navigation; it was shown that the convenience of lading the vessels far outweighed the nuisance?—Yes, it was; but that case has been overruled, and this case of the tallow-chandlers has also been questioned as being very doubtful law.

3130. Then it is no defence to an indictment with regard to a navigable river to say that although the work is a hindrance to navigation, it is advantageous in a greater degree to the other uses of the river?—I think that that seems to be the result of the overruling.

3131. Then, if sewers, by flowing into a river, raised the bed of the river, and injured the navigation, could one plead as a defence to the indictment that the convenience of allowing the sewers to run into the river would be very great? —I think not, as that would be an injury to the navigation.

3132. Is there not a very early statute of the 12th of Richard II. c. 13, which is in conformity with the common-law proclamation against throwing filth and corruption into rivers?—Yes; there is a very remarkable statute of the 12th Richard II., which is made in affirmance of the common law, and it prescribes that proclamation be made against throwing filth into rivers.

3133. And also pools, lakes, ponds, or any water near a city or borough?—It says "Ditches, rivers, and other water, and also many other places within, about, and nigh unto, divers cities, boroughs, and towns of the realm, and the suburbs of them; whereby the air is greatly corrupt and infect, and many maladies and other intolerable diseases do daily happen, as well to the inhabitants and those that are conversant in the said cities, boroughs, towns, and suburbs."

3134. Were not the Mayors bound to compel the offenders to remove that filth?—Yes; the proclamation was to be made against the committing of this offence.

3135. And the offenders were to be brought before the Lord Chancellor, were they not?—It is a very singular case of centralisation. They might sue the offenders before the Lord Chancellor, who might punish them at his discretion, and for that purpose there was a form of writ to be had.

3136. How do you suppose that the progressive pollution of the river Thames proceeded; was it from one of those maxims that you have mentioned?—In the first place, until the Commissioners of Sewers undertook drainage for the purpose of house refuse, as at present understood. And then it passed from the individual owners of the houses, and the layers out of the streets into the jurisdiction of the Commissioners.

3137. Is the practice of polluting the Thames not only in contravention of the common law but of the statute of Richard II, which you have just quoted?—There is no doubt that it would be so. The most extensive operations were those made by the Commissioners of Sewers in 1847.

3138. What were those operations?—That is described in a report from Mr. Roe and Mr. Phillips, the surveyors. This was when all the Commissions were put in the same names of several men who were very eminent for sanitary inquiry. The surveyors here report: "As regards the cleansing of courts and alleys, and the cesspools, we have emptied the contents of cesspools into the sewers by means of pumping. For this purpose, we have used a fire-engine, with hose attached, one end of the hose being inserted into the cesspool, and the other put down the nearest gully-drain. The New River Company kindly sent their turncock to supply water for diluting the contents of the cesspools. The experiment of conveying the soil from the cesspools to the sewers by the means employed was decidedly successful, and much less expensive than the ordinary mode of emptying them."

3139. How do you justify this contravention of the common law and of the statute of Richard II.? —I suppose it must be *pro salute publicâ*; they considered that they were doing a greater benefit to the general health of the metropolis by those means than any injury that could accrue to the river; and at that time there were many people who considered that the injury to the river was too minute a question, in comparison to the injury to public health, by this putrefying matter remaining in the cesspools. Their first object was to get rid of the matter from a state in which they considered it to be injurious to the public health, in the midst of dwellings, and then to discharge it into some place where they considered that it would be comparatively innocuous.

3140. The sewers used to retain this matter, and the difficulty was to get it out of the sewers, was it not?—All those sanitary reports exhibit the sewers in a state almost entirely clogged with deposited matter. Excepting in one of the Commissions, they were not flushed, and the contents of the sewers, therefore, had to be removed by hand from the sewers. Sewers in that state were condemned as being elongated cesspools themselves, and therefore they were flushed out into the river, as had been the practice before in Holborn and Finsbury. From this source, no doubt, the mass must have been immense.

3141. The only object was, for the sake of the public health, to remove this noxious refuse, because it contaminated the houses, they never taking into consideration the pollution of the river, which was contrary to law; was that the case?—That was a matter for subsequent consideration, no doubt. All their reports show that they always contemplated making use of the matter as a fertilizer. I refer to the late works of the Sanitary Commissioners and others. In the reports of the Sanitary Commissioners, they dwell

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dwell upon the advantages arising from the application of this matter to the land; they, therefore, did not contemplate the pollution of rivers as a consequence to be perpetual, but only as a state of things of a transitory nature.

3142. Then, in olden times they used to apply the refuse of houses to the land; and then, when they began to flush the sewers into the river, they still contemplated applying that refuse to land as soon as it could be availably done?—I think that might be fairly so stated.

3143. But in the meanwhile, until arrangements could be made, they allowed it to flow into the river contrary to law?—I think it is contrary to law. But when you find a series of Acts of Parliament of the nature of those that we have been considering, evidently contemplating that result, and there being no known means of preventing the nuisance, and no means pointed out by the Act of Parliaments of preventing it, and some of them containing no prohibition against the nuisance itself, you must almost conclude that the Legislature legalised the practice.

3144. There was no Act to legalise the practice, was there?—All those modern Acts of Parliament go upon the notion that this state of things is to be produced; that they are to have the sewers; that they are to have private drains from houses into sewers; that those sewers are to empty into large sewers; and that those larger sewers are ultimately to discharge. Well, then, when the Legislature contemplates that state of things, it must also be said to contemplate the consequence, because it had made no provision as to the ultimate application of the refuse.

3145. Did not you state that they contemplated that the remedy would presently be provided for the pollution of rivers, by the distribution of the refuse over the land?—That was the Sanitary Commission that I referred to.

3146. Do not you suppose that the Legislature contemplated that that pollution should be soon remedied by the distribution of the sewage over the land?—They could scarcely have given the subject at that time full consideration.

3147. But still you could hardly say that the Legislature legalised the practice, except in a very temporary manner?—It can be said that it was contrary to the general spirit of the law.

3148. And it might be remedied, might it not, by harmonising the spirit of the law with the letter of the law?—That would harmonise the law.

3149. You do not suppose that the Legislature intended altering the law, but doing away with the nuisance?—As they did not give positive authority to do those things, or exempt them from punishment, and did not repeal the old laws, we may suppose that they did mean to do something of the sort; but, in all probability, the subject was not sufficiently pressing to call for a remedy.

3150. In that way, the matter which should first have been taken into consideration was put off, and in this way the river became polluted by means of the introduction of a new system, without at the same time providing a remedy?—No doubt, because the remedy now provided by the Metropolitan Main Drainage Acts is the last thing of all.

3151. By the Nuisances Removal Act, 1848, was not the casting of the sewage into ditches or water-courses, after that date, declared to be a misdemeanour?—Yes, but that was a temporary Act that Act has expired, and it has been renewed but in the renewed Act that provision is not found.

3152. At what date was it renewed?—In 1855. No doubt the Legislature began to think it inconsistent that they should prescribe so often that there should be town sewerage, and that they should then prohibit, under the penalty of a misdemeanour, the carrying of any drain into a water-course.

3153. Under the Public Health Act and the Local Government Act, it is permitted to collect the refuse for sale, is it not?—The Public Health Act directs that the refuse shall be collected for sale, and also gives authority to discharge into rivers, provided that no nuisance be thereby created.

3154. It gave the Local Board power to make sewers into rivers, did it not?—It does, provided that no nuisances be created thereby.

3155. Or they may erect works for the collection of that refuse for sale under the same Act, may they not?—Yes, they may collect the refuse for sale, but so as not to create a nuisance. That is the Public Health Act of 1848 which directs the Local Board to cause the sewers to communicate with, and be emptied into, such places as may be fit and necessary, or the sewage and refuse to be collected for sale, but so as not to create a nuisance.

3156. But does it not also state that they may erect works for the distribution of the sewage, and may contract with any company or person for the sale of the sewage, or for the distribution thereof upon the land?—I think that that is the Local Government Act of 1858, that is, ten years after the Public Health, and that later Act gives some more extended powers for the same purpose.

3157. Under the Local Government of 1861 no sewage is permitted to be discharged into a river until it is freed from all noxious matter; is not that so?—Yes; that is an amendment of the Local Government Act of 1858.

3158. Mr. *Ferrand.*] Is that a general Act?—Yes; that is the Act under which all the Local Boards of the country are. There is also another of the Local Government Acts which has a peculiar provision in it, that is, one for the Town of Leamington. In that case it was required that before the sewers were discharged into the river, they should obtain the certificate of the Inspector of the Board of Health that it was so arranged as to produce no nuisance.

3159. Mr. *Adderley.*] Was that a Local Act?—That was a Local Act, or it might be the general Act confirming the provisional order for Leamington; but it had that peculiar provision assigning a judge who was to determine that the outfall arrangements were compatible with the public health, so far as regarded the discharge into the stream. That provision became nugatory when the General Board of Health dropped.

3160. *Chairman.*] Can you give the Committee any instances of the application of the statute law to the pollution of streams by the discharge of sewage into them; for instance, the Uxbridge case?—I do not think that the Uxbridge case is reported in any report; but it is to the same effect as the Birmingham case, and the Luton case, and several others.

3161. It was tried before Vice Chancellor

Wood, was it not?—I think so; most of those cases were before Vice-Chancellor Wood.

3162. Did it not turn very much on the fact that Professor Way had stated in evidence that there was no power in science by which the water could be purified from all offensive matters?—I do not know that case *per se*.

3163. Could you give the Committee any information about the Croydon case?—The Croydon case has been before the Courts on very many occasions; but it is so fully stated in the reports two years ago of the Sewage Committee of the House of Commons, of which Dr. Brady was Chairman, that I think it would be unnecessarily occupying the time of the Committee to go into that.

3164. Is the legal part of the case stated there?—Yes; the several measures that they had to take in order to produce the desired result.

3165. Are you acquainted with the case of Mr. Adderley, at Birmingham?—That is reported; that appears to be the case of a landowner setting in motion the Attorney General to file a criminal information for polluting a private river.

3166. The information was against the town of Birmingham, was it not?—The information was against the Corporation of Birmingham.

3167. And it turned upon the point that the cattle could not drink the water of the river, did it not?—I believe so, that it was a public grievance, because the river was rendered unfit for cattle to drink of.

3168. What was the result of that information?—They had a judgment against them, clearly; there was an injunction that they should not continue the pollution of the stream.

3169. Were all those cases with regard to private rivers or public rivers?—That was a private river.

3170. Were the cases at Croydon, at Uxbridge, and at Luton, private rivers?—They were all cases of private rivers.

3171. Mr. *Adderley*.] What do you mean by private rivers?—Not navigable; that is the general exposition of the word; "private" rivers are private rivers in which the public have no right to fish and to navigate.

3172. *Chairman*.] There seems to be nobody whose duty it is to see that the navigable or public rivers are not polluted, and made offensive; is not that the case?—That appears to be the case, except in the instance of the Conservators of the River Thames, to which I have alluded before, where they prosecuted a gas company; whether the Thames Conservancy have any authority that they could exercise, I do not know.

3173. Was there not a case of Oldacre *v.* Hunt, which was a case of a landowner who lived on a stream, getting an injunction against a Local Board for exceeding its jurisdiction, and allowing sewage to be thrown into that stream?—Yes, he claimed a right of fishery in that river, and the pollution was to the prejudice of the fishing; that was a private proceeding.

3174. Mr. *Ferrand*.] Did he obtain an injunction?—Yes; but his private damage was to be tried before a jury.

3175. Did he get a verdict?—He might have obtained a verdict.

3176. *Chairman*.] Do you consider that the law against the pollution of streams is sufficiently stringent?—I think clearly not.

3177. Why is it not sufficient?—There is no recognised conservator or party to protect the stream.

3178. Ought it not to be the business of some functionary or person to see that the streams are not polluted?—If it be an object that the streams should not be polluted, it seems to be indispensable that there should be somebody to set the law in motion.

3179. In fact, the law itself is sufficient, and all that you require is somebody whose duty it should be to put that law in force; is that so?—In the application of the law to the case there would be a great difficulty, no doubt.

3180. Did not the Board of Health Act of 1848, put the law in force?—The Board of Health Act of 1848, had not got so far; they had got the sewage into the stream, but they had not taken any means to get it out; their first object was to get it from the dwellings; we may suppose that if their authority had been continued, they would have worked out the problem.

3181. They thought that no time was to be lost in getting the sewage into the streams, so as to save the health of the people?—I think that that appears to have been their policy.

3182. And they thought, perhaps, that the nuisance would be so great when the sewage got into the stream that the people would be glad to get it out again as quickly as possible?—Perhaps so. Perhaps they thought, that the greater the nuisance the sooner the remedy would be applied.

3183. It has been stated in evidence before the Committee, that most towns allow their sewage to flow into their rivers, and, in fact, do not keep their dirt to themselves, to use the words of Lord Chief Justice Holt?—By those very cases, which are so often reported in the books, it appears that that has been the general practice.

3184. Then in fact, each town which is on a stream, and sends its sewage into that stream, sends it on to the next town below it?—So it appears, although the law says that they are not to create a nuisance.

3185. In fact, they do it to preserve their own health, and to the injury of the health of the next town?—Yes.

3186. Then in one basin of a water-shed, or what is technically called a catchment basin, it is of very little use for one town to prevent its sewage from going into the stream, unless all the towns above it in the same catchment basin adopt the same precaution?—There is the difficulty about the contributions in the case of each catchment basin.

3187. For instance, although we may drain London and send our sewage some miles down into the river, still we are drinking water which is polluted with the sewage of some 800,000 persons; is not that the case?—Yes; and all that they do in London is to take the sewage to some other place.

3188. But do not the London people get water which is polluted by the sewage of Oxford and of Reading, and of other places on the Thames?—No doubt.

3189. Have you heard of the case of Salford, where they proposed to utilise their sewage at an expense of 80,000 *l.*; they proposed then that the other towns in the basin should do the same, but those other towns refused to adopt the remedy,

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remedy, and so the plan was abandoned?—I have heard of that.

3190. With regard to gas refuse, are there not Acts preventing gas refuse from flowing into rivers?—All Gas Acts prohibit the gas refuse from going into rivers, under very heavy penalties, but they do not prevent the practice.

3191. Do you think that there ought to be some board or some authority for each catchment basin, which must be appointed, with adequate powers to prevent the pollution of streams?—I think, that taking analogous cases, one of the closest of which, perhaps, is the late legislation upon salmon fisheries, it would be requisite to have some sort of district and some sort of body, which one may say is exemplified in the different way of treating those salmon fishing questions in England, in Ireland, and in Scotland. You may set about it in different ways. I think that there is no board in England for salmon fisheries, but there is a board in Ireland, and there is a board in Scotland, under which they make a jurisdiction and have the power of enforcing the law against parties who pollute the rivers to such an extent as to destroy the fish, that is an active executive board with power to levy rates in order to enforce the law.

3192. Does their authority extend over the whole of Ireland, or of Scotland, as the case may be?—The Commissioners' authority extends over the whole of Ireland and of Scotland; they form districts and appoint a board, and they or the board have authority and power of instituting prosecutions.

3193. Do you conceive that that would be better than to have a separate Local Board for each catchment basin or water-shed?—I think that you could not have a mere Local Board for each. If you went upon that principle, you must have some delegates from the several boards to meet upon the common concernment of the outlet.

3194. Does not it seem to you that if unity of action is preserved throughout a catchment basin, that would be sufficient to prevent the pollution of the stream which drains that water-shed?—I think that if there was a powerful Board that could enforce the law, as well as agree upon some plan by which the towns themselves would cease to be contributaries to these nuisances, perhaps it might be got rid of; but it is attended with a vast deal of difficulty, because it involves not only the question of the town, but also the question of the trade nuisances in the rivers.

3195. Supposing that there were this Board for a catchment basin, and that exactly the same powers were given to that Board which are now given to any Local Board of a town, do you not conceive that that would be sufficient?—No, I think not.

3196. Why do you think that it would not be sufficient?—I think that it would require some superior authority. I do not think that a Local Board of itself would ever devise the means of dealing with the nuisance.

3197. If those Local Boards were put under the Home Office, or under the Board of Health, in London, and the Home Office should issue a mandamus to make them enforce the law, would not that be better than to have a central Board in London?—That would involve an inspection by some officer appointed by the Home Office, some authority to take proceedings, some fund out of which the expense of the proceedings is to be defrayed; and in fact, if you trace it out, it requires pretty nearly the whole machinery of a central authority, and a district authority also.

3198. Is there now no inspection, and no funds requisite for the management of Local Boards?—No, Local Boards levy their own funds for the definite purposes of their Acts of Parliament.

3199. Then, are not Local Boards supervised in the carrying out of the Local Government Act?—Except in some few instances of contract, it cannot be said that they are looked after at all.

3200. But does not the system work pretty well?—It produces some advantages and some disadvantages.

3201. Mr. *Adderley*.] What, then, are the functions of the Local Government Office?—The Local Government Office have the control of works in the way of mortgaging, and they have the power of constituting a district in the first instance, and of getting the provisional order.

3202. Do not they exercise the power through inspectors of compelling Local Boards to do their work?—I think not as regards a nuisance or anything of that sort, but that could be tried in any of these cases.

3203. *Chairman*.] Then we come exactly to the same point as before; if the Local Government Act seems to work well when confined to Local Boards of towns, why should not a similar law work equally well if, instead of having the Local Boards of towns to deal with, you had a Local Board extending over a whole catchment basin?—It would require some one to appoint the catchment basin; that is to say, to define the district, which is, in the first place, the business of a central authority.

3204. Has not the district been already defined geographically by the water-shed?—The district, by nature perhaps, may be defined, but that is not sufficiently definite to work upon by any process of law.

3205. Supposing that your object is to secure the discontinuance of the pollution of streams of water, and therefore that you must have unity of action throughout the whole catchment basin or water-shed, would it not be the best means of obtaining that object to appoint a board for the catchment basin, which should have exactly the same powers as are given to the Local Boards now under the Local Government Act?—Yes; but in order so to do, Parliament cannot itself legislate in each case; they must have it brought forward by some authority. It must be propounded; in fact, ready cut and dried to their hands. It involves the necessity of an investigation on the part of some of the Government authorities, in order to ascertain the district which is to be made and exactly defined, so as to form the jurisdiction of the local authority.

3206. Supposing that we were to say that the Local Government Acts, instead of applying to towns and boroughs, should apply to those basins which are geographically defined by water-sheds, would not exactly the same machinery, and the same amount of inspection be as efficient in that case, or even more efficient than it is now, with regard to the numerous little Local Boards of all the towns?—I think that it would be requisite to keep a much stricter hand over them, the subject being a great deal larger, and involving a great

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many more interests, both public and private, and I think that it would be necessary to have a much closer contract on the part of the governing authority.

3207. Then you are rather in favour of one great central authority instead of those Local Boards?—A central authority may appoint the Local or District Boards, just as in the case of the Irish and Scotch salmon fisheries where they take the stream and all the tributaries of the stream. But the Commisioners there assign the districts in the first instance to the Boards and authorities who are to carry out the law locally on these several rivers and their tributary streams; amongst other things they have this very case to provide for; they have power to prosecute traders and manufacturers, whose works pollute the streams.

3208. Then how far do you agree with the suggestion which has been made to you; you allow, do you not, that this is for the general good, and that therefore it must not be left to individual action?—Certainly, I think so.

3209. And you are also of opinion that it ought to be under Local Boards for the catchment basins, but you think that those Boards ought to be more directly under the management of, and appointed by, a central authority in London?—The district should be assigned, I think, by some central authority. The Boards might be elected or appointed in some way, but that is quite a subordinate question.

3210. Supposing that instead of assigning the district we were to take the appointments of nature, would that, in your opinion, work satisfactorily?—I do not think that you could successfully do that.

3211. Why could not that be done?—Because, in order to have anything safe and practical, you are obliged to define so closely by maps and plans, and metes and bounds, that I do not see how the object could be obtained by taking the mere geographical limits of the basins.

3212. Can anything be more definite and more minutely defined than a water-shed?—If it involves the question of taxing all the people in that water-shed, it would then become a question of which of the owners of several of the places within that water-shed were at all interested in the question, and whether they ought to be comprised in that taxation or not.

3213. Then is the only difficulty that as to the taxation?—There is that of jurisdiction in all questions.

3214. Then would you leave the definition of the district to some central Board in London?—Yes.

3215. Would you leave the appointment of the chairmen and members of these Local Boards to the central authority?—No; they might be locally appointed.

3216. Perhaps the chairman of the quarter sessions and the chairman of the Board of Health should be *ex officio* members, and the rest should be elected by the ratepayers; would that be your view?—Some expedient of that sort might be adopted.

3217. Are you aware that some of these catchment basins cover an area of 2,000 square miles?—I believe that some of them comprise several counties; because rivers are so often the boundaries between counties that they would include several counties.

3218. In order to prevent travelling expenses being an item of this Board, ought you not to have a high qualification for election, so that members should pay their own expenses?—I really am not prepared to go into those detailed questions.

3219. What powers would you give to these boards; would you give them the same powers as are given under the Local Government Act?—They would require more extensive powers than those.

3220. Under that act, they have power to raise rates, have they not, as well as to prevent pollution?—Certainly.

3221. And have they not power also to enter lands to carry their works through, just as a railway has?—Clearly so; just the same as a railway, except that they do not take the surface of the land.

3222. And have they not power to lease for the establishment of these works?—They have power to take land on lease.

3223. They have power to purchase land, have they not?—They have power to purchase land by voluntary arrangement; but that would not be sufficient. They would require compulsory powers in many cases; but under the Local Government Act they have voluntary powers only.

3224. Do you think that compulsory powers would be necessary?—In some cases I think they would.

3225. Would there be any other powers necessary?—I think that probably it would be necessary for them to make rules and regulations of the nature of the old Sewer Ordinances.

3226. Would you allow each district to make its own rules and regulations?—They would have to be controlled, because everything which is effective in this way must intrude very largely indeed into what may be called individual liberty. Indeed, there are so many things done that are productive of the pollution of rivers, that if the process of cleansing them is to be put into operation fairly and equally, very considerable control must be exercised over operations in houses, in manufactures and in land, all of which tend more or less, in the way in which things are managed now, to produce that pollution, and it would not do to deprive manufacturers, for instance, of what they consider to be their vested privileges, unless you put control upon the contributions made by the land to the nuisance; nor would it be right to throw any impediments in the way of ridding the houses of the sewage matter.

3227. But you consider, do you not, that something of the sort is necessary?—No doubt, something of the kind is necessary, if the present state of things is ever to be altered.

3228. According to the evidence which you have already given, it would not be contrary, either to the principles of ancient law or modern legislation, that such a course should be taken?—I think it is clearly shown to be conformable to the principle of ancient law, and also to the modern cases.

3229. Mr. *Ferrand*.] From the attention which you have paid to this question, are you aware of any attempt that has ever been made to apply sewage profitably to the cultivation of land?—I have heard of several cases, but the one which appears to be the most promising is the case of Croydon; but that, I think, is already before this Committee,

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Committee, in the Report of the Committee on Sewage of Towns, which sat in 1862.

3230. Is the sewage removed by hand or by carts in any part of London at the present time?—That I cannot say at all.

2231. How is it removed in the outskirts, where they have no connecting drains with the main sewage of London?—It would be necessarily removed by hand or by carts in those districts.

3232. Are you aware at what hours the sewage is removed; is it in the night time?—It is, as a general rule, under local Paving Acts: they prescribe that it shall be done at certain hours of the night.

3233. In the outskirts of London, at the present time, is it not removed either by day or by night, as it suits the people to get rid of it?—Yes, because in such places as have no Local Paving Acts, there is nothing to limit the hours when the work should be done, so that it would be open to parties to do it when they pleased.

3234. So that it must be offensive to the public in that case?—No doubt.

3235. Is it not unlawful to pollute a stream by increasing the volume of pollution which is already in existence in it?—I suppose that it might be said to be so if the law would take notice of it; but if the law does not take notice of it, as being too trivial a matter, then, practically, it amounts to an exemption.

3236. Are not the proceedings by law, under these circumstances, very expensive?—I think that they must have been very expensive in all these cases.

3237. And are they not expensive even at the present day?—They are expensive, and I think they must have always been expensive.

3238. Is it not usual for every impediment to be thrown in the way of a person complaining of such a nuisance?—No doubt; parties have to resist it, and they resist it by any means that they can conveniently lay hold of, and they think that they are acting in discharge of a public duty.

3239. Is it not also difficult to produce the proof of the pollution of a stream against any person?—The cases show that where such a body as a Local Board of Health has been proceeded against, you can deal with them as causing the nuisance in a mass, and that they cannot stand upon any supposed vested rights of individuals to contribute to this nuisance, but that they are responsible for the consequences in the form in which they present it, so that they have been proceeded against successfully in several cases so far as regards the law; but what the actual result has been does not appear by the law books. After all, the injunction, or the indictment, or the information may be a *brutum fulmen.*

3240. Are you aware of any action which has been brought by manufacturers in London for polluting streams?—I do not know of any such case within my own knowledge.

3241. Has it come within your knowledge that the manufacturers are very strict in enforcing the purity of the stream when it is their interest that it should be left pure for the purpose of carrying on their trade?—There are several cases in the law books where they have proceeded against each other for a supposed injury of that kind. But the Court of Chancery has been rather disinclined to interfere in such cases.

3242. But still do they not shew a very determined interest in preventing the pollution of water which they require for the purposes of their own trade?—Certainly.

3243. Are you aware that those manufacturers who do show that anxiety are also very reckless of the damage which they do to people who have property below their manufactories, after they themselves have finished with the water?—I think that that clearly appears, even by the provisions of the late Salmon Fishing law, because those are provisions against manufacturers for polluting streams, and you find those provisions so guarded to protect what are supposed to be the vested rights of the manufacturers, as to shew that they set very great store indeed by the conveniences that they have.

3244. Having used the water pure for their own works, they do not hesitate to turn the refuse which they have created by their manufactures into the stream, to flow down to their neighbours below?—I am afraid not.

3245. Is it your opinion that the persons who are thus injured should not have redress more easily obtainable by law than it is at the present time?—It would be desirable; but there seems to be a difficulty in the present state of the law.

3246. In your opinion, is it not fair and just that they should have that redress?—I think that it is right that everybody should receive the gift of nature in the way that Providence has given it, that is, that the water should be pure in its passage.

3247. Do you think that fresh powers in Acts of Parliament are absolutely necessary for this purpose?—I think that fresh powers are necessary for that purpose; but I think that to produce the desired result the law must be enforced conjointly against Local Boards and manufacturers, and possibly to some extent against those using artificial manure upon land. I think that the whole subject requires some sort of control over it.

3248. As it is so expensive now for private individuals to protect their interests by the law as it at present stands, do you not think that there ought to be some cheaper mode or some cheaper process, and further Acts of Parliament, to enable them to protect their property?—I think it would be very desirable.

3249. Is there not, also, at the present time, a risk as to the decision of the jury, although it may be clear that injury has been done, and that the law has been violated?—I think that there would be, in many cases, a very great difficulty in obtaining a verdict, and particularly against individual manufacturers or others, more than against public bodies.

3250. And would not that be more the case in manufacturing districts?—In the manufacturing districts, I presume, everything would be defended, regardless of cost, if it was convenient or necessary to the prosecution of the manufacture. Indeed, that is seen by the great opposition that is made to everything that is intended to curtail the operations of manufactures. Take the instance of the alkali works.

3251. You have given some evidence upon the question of navigable rivers; in navigating a vessel in rivers and canals which are polluted with sewage, does it not stir up the rivers and produce an offensive smell?—I should think it must do so; but my knowledge of navigation is not sufficient to enable me to speak accurately on that subject.

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3252. Is there any Act of Parliament in existence that authorises the pollution of a stream?—There is not, except inferentially. As I have described to the Committee, those Acts of Parliament contemplating a state of things which must produce a result, may be said, as they have not prohibited the result, but have laid down the whole train of consequences, to have authorised the practice, and inferentially, I think, it may be said that they have sanctioned it.

3253. Mr. *Adderley.*] But no Act of Parliament could authorise a nuisance, could it?—If the Legislature think that there is an advantage in the prosecution of a certain course of action, and prescribes that course, although it has not repealed the general law of nuisance, it may be said to have legalised that course.

3254. Mr. *Ferrand.*] Have any Commissioners, under a private Act, the power of turning the sewage of a town into a river, and thereby increasing the pollution of the water?—By the Local Government Act, and the Public Health Act, they have powers to discharge into the rivers and streams, so as not to create a nuisance.

3255. Have they power to increase the pollution, so as to injure the health of the people, and create a nuisance?—That brings you to the legal definition of what a nuisance is; undoubtedly, these would be nuisances, if they kill the fish, injure the health, or render water unfit for cattle to drink—and there are cases which have established the law against the offender, and therefore it must be considered to be still the law, the authorization in that case being as above stated, that the work must be done so that it does not create a nuisance.

3256. Then would this be the process which a private person would have to undergo, to obtain redress; first of all, to go to the Court of Chancery to obtain an injunction—the person against whom he applied might oppose that injunction, and the Vice-Chancellor might direct an issue from his Court, to try to what extent the stream is polluted, by an action at law, at the Assizes before a Jury—it then would rest whether the person complaining got a verdict—and if he got a verdict, he would then have to go back to the Court of Chancery to have the injunction issued and enforced against the person who committed the injury—is that the process which, at the present time, a person has to go through before he can obtain the slightest redress for the injury done to his property by the pollution of a stream?—Yes; and there are cases which show that that process has been gone through in the order in which the Honourable Member has described it, and then, ultimately, the Vice-Chancellor has refused to continue the injunction. That is the process by means of the Court of Chancery, but the complainant has the common law of indictment.

3257. Supposing that he brought an action at the Assizes, would there not be the power of appeal to the superior Courts?—The action would be for private damage; it would be like all other cases; it might come to the Courts above, and go through all the Courts of Appeal, even to the House of Lords.

3258. Would not an Act of Parliament, giving summary jurisdiction and penalties before magistrates, be sufficient to give redress, both to the persons complaining, and to the person who was complained of?—In many cases, as is seen by the care taken by the trading interests, and the manufacturers in those recent Acts such peculiarly difficult questions of law are raised, that I am very much afraid that in such cases as those, where a large trade interest is concerned, such a jurisdiction would not be satisfactory.

3259. Then is it your opinion that those difficulties can only be overcome by an Act of Parliament?—By preventive measures.

3260. Should those preventive measures be enforced or carried out under an Act of Parliament?—I think so.

3261. Should there not be clauses prohibiting drains from having any connexion with rivers and streams from which sewage or refuse from manufacturing works is conveyed into rivers?—It may be said now that the effect of the law is to produce this state of things: yet the law only allows you to drain into the river, provided you cause no nuisance; if you do not comply with those conditions, you do not act under the authority of the law, in the cases of the present Local Government Act, the Public Health Act, and others.

3262. You have stated that there would be, and are, the greatest difficulties in enforcing the law in the manufacturing districts; but if a manufacturer sets the law at defiance, and conveys by a drain the filth and refuse of his mill into a stream or river, in which act he is violating the law, do you see any reason why he should not be prohibited from having a connecting drain with that stream?—I see this difficulty; it is the very case that is put in the Salmon Fishery Acts; he is there supposed to produce results which cause the destruction of the fish. One would think that a similar prohibition would be just the thing to meet this case; but if you refer to those Acts you will find that they are clogged with a variety of clauses as to the time at which he is to set about correcting the nuisance from his works, and as to whether he has not a right to do it, and a variety of questions, carrying out the process through many operations. I have made extracts from some of those Fishery Laws, which bear a closer analogy to the present question than you would find in anything else, because the subject has been taken up as being of importance to the food of the people; and in the Reports on the Fisheries, in which the evil complained of was principally fixed engines, there is mention also of the collateral evils of the pollution of the rivers by means of the refuse from towns and from manufacturing works. In consequence of this, it is evident that those clauses have been introduced into those recent laws; but instead of their being simply introduced, as one would wish and expect, you will find that they are clogged with conditions which would be exceedingly difficult to work, and quite impossible to be disposed of by any summary jurisdiction.

3263. Does not that show the necessity of the law being altered, to give greater power to prosecute those who really have no right to destroy the purity of the stream?—That is, of course, the question which they raise.

3264. Will you take those cases as to which no question can be raised; for instance, unless a man has got a right, by the lapse of time, during which he has followed this course for 20 or 40 years, whatever the time may be, by law he has no right whatever to drain any foul pollution into a river or stream; is not that the case?—Strictly

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Strictly speaking, he ought not to be allowed to enjoy a nuisance for any length of time whatever, because the length of time ought not to legalise a nuisance. It may be what the law would consider an "estoppel" to any individual from the right of complaint, that that individual had been precluded from the right of complaint by reason of a consent, or grant, or acquiescence on his part; but in the case of a public nuisance, no such right ought ever to be recognised.

3265. For instance, supposing that a manufacturer in my neighbourhood was building dye works, alkali works, or paper manufacturing works, and he was preparing a drain to convey the refuse and pollution from his works into a stream of water belonging to me; that I had no power whatever to prevent that drain from being made; that after I had given him notice that if he did pollute the stream I should bring an action against him, or take legal steps to protect my property, I found that that stream was continually polluted by this person, but that I had no means of entry into his works, and no means of knowing at what hour he chose to drain this pollution into the stream, to my serious damage and to the destruction of my fish; in such a case, would it not be fair and proper that there should be an Act of Parliament to prohibit that man from entering that stream, and so polluting it?—Yes; I think it is an unlawful act, but the means that you are to have practically to redress it, is the question still. I am afraid that a summary jurisdiction cannot be trusted to deal with it.

3266. Supposing that the law should prohibit that man from having any connecting drain with any stream of water, is there any injustice in such a clause as that, when it is notorious that if he does put that foul refuse from his works into the stream it is an illegal act?—It would be so dangerous a measure to say generally that an individual should have a right of stopping a manufactory, that I think you must give a full opportunity to a manufacturer to allege everything that he can, before you can undertake to put a stop to his works.

3267. Then, are you still of opinion that there can be no redress to a private individual, except through all the legal processes which I have described?—I think so; because to take the most recent instance, and the closest analogy, viz., that of the Salmon Fishery Act, I find that there is a prohibition against a person who throws into any waters containing salmon, or into any tributaries thereof, any liquid or solid matter, to such an extent as to cause the water to poison or kill the fish. There is a series of penalties for that; first, there is a penalty of 10 *l.*; on a second conviction there is a penalty of 2 *l.* per diem, and on a third conviction a penalty of 20 *l.* a-day; then come these restrictions and qualifications upon it. But no person shall be subject to the foregoing penalties for any act done in the exercise of any right to which he is by law entitled, if he prove to the satisfaction of the Court before whom he is tried that he has used the best practicable means, within a reasonable cost, to render harmless the liquid or solid matter so permitted to flow or to be put into waters; but nothing herein contained shall prevent any person from acquiring a legal right in cases where he would have acquired it if this Act had not passed, or exempt any person from any punishment to which he would otherwise be subject, or legalise any act or default that would, but for this Act, be deemed to be a nuisance or otherwise be contrary to law."

3268. But does that Act apply to the case which I have brought under your notice, namely, that of a manufactory which has just been built, and where no right can have been gained?—The Act goes on to provide, that "where any proceedings are instituted by any complainant against any person for the recovery of any penalties alleged to have been incurred by him under the last preceding section, if such person, hereinafter referred to as 'the defendant,' on appearing before the justices constituting the Court by which he is to be tried in pursuance of this Act, alleges by way of defence, that he has used the best practicable means, within a reasonable cost, to render such matter harmless, and proves to the satisfaction of the Court, that in the event of the complaint being decided against him, the expense of permanently preventing the matter complained of would, exclusive of costs, exceed 100 *l.*, and gives security, to be approved by such Court, duly to prosecute his appeal, and to abide the event thereof, all proceedings before the justices shall be stayed."

3269. But you must allow me to remark, that that does not again apply to the question which I have brought under your notice, that is, where a man has got a right; is it your opinion, that where a man has no right, and where it is distinctly clear that he violates the law, he has a right to have a drain connecting his works with a stream of pure water, through which drain he can and does cause the pollution to flow?—I think he ought not to be allowed to have the drain to cause the pollution.

3270. Then, is it your opinion that it would be an act of justice towards the general public that such drains should be prohibited?—I think so.

3271. Are you aware that if any person or company turn the refuse from gas-works into a river or stream, the company or the person is liable to a penalty of 200 *l.*?—There is some certain penalty in all gas Acts, and in the Nuisance Removal Act.

3272. Is it within your knowledge that gas-works very often have connecting drains with rivers and pure streams of water?—I have understood so, and have known it in several cases, and I believe it to be the general practice.

3273. Do you not think that the law under such circumstances as I have mentioned, ought to prohibit those connecting drains?—I think it should, and the law does prohibit them by means of a penalty. But what is wanted is an abatement, as I understand it, a jurisdiction to go into the works, and actually to put a stop to the drain; that is, in fact, to stop the works, because it effectually comes to that. They could not carry on the operation of the works unless they had some means or other of disposing of their products.

3274. But are there not plenty of gas-works in this country which are entirely unconnected with streams or rivers?—I should think that all of them nearly must have some exit or other; but they have learnt by compulsion to make valuable many residual products that they previously threw away, to the nuisance of their neighbours.

3275. But are there not many gas-works carried on where they inflict no injury on their neighbours,

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neighbours, and pollute no streams?—I suppose they do not in some cases, or there would be more proceedings against them.

3276. But can they do so?—I do not know. I have understood that the great nuisance which they have committed in the streams to some extent has been got rid of; that they have learned to make a profitable use of that which was previously injuriously thrown into the stream. No doubt, with improved knowledge and science, that might go on; but whether you could compel the people peremptorily, by means of the order of petty sessions, or any readily accessible jurisdiction, to put a stop to the works in this particular, which probably would involve the stopping of the works altogether, as yet I am not prepared to say.

3277. Are not Local Boards and Improvement Commissioners generally formed of persons who have an interest in polluting the streams, where those Local Boards and Improvement Commissioners represent the manufacturing districts?—I think not.

3278. Were not gas companies compelled to desist from letting gas refuse flow into streams and rivers before they knew it could be turned to account?—The knowledge was forced upon them; they were obliged, in order to avoid the penalties of the law, to turn their attention to making a better use of their products, and there is no doubt that they have done so to their own very great advantage, as well as to the advantage of the public.

3279. The gas refuse now ceases to flow into the streams, does it not?—It might be made to cease. In many instances it has been intercepted and turned to valuable account. I think that you must take the case of Local Boards to be this, that they act in execution of power entrusted to them to produce certain results which the Legislature considers to be indispensable for the public health. The ultimate consequences that would follow from those things, producing the mischief and inconvenience which the Committee enquire about, is not the end that they seek, but that mischief and inconvenience arise from causes to a great extent beyond their control. That is the case of Local Boards, I think, whether in manufacturing districts or not.

3280. There is a case in point: The Local Board of Health of the town of Keighley, in Yorkshire, has refused to take any steps to prevent the manufacturers and iron foundry owners in that town from throwing their engine ashes into the brook or stream which flows past the town. That brook or stream has had its bed raised some 10 or 12 or 14 feet; and although it is seriously injurious to the health of the people residing in that town, and that although constant, frequent, and urgent complaints are made to this Board, still they refuse to act or to take any steps to prevent it, because the persons implicated in producing this great injury are members of that Board. What would you propose as a remedy under these circumstances?—I think that preventive measures are the best, such as would probably arise from intercepting those sewers, and generally of a large description. But, beyond that, a body less interested in the locality than the members of the Board of Health, in such a case as the Honourable Member has put, would be better to be entrusted with the power of enforcing the law. Undoubtedly that is an infraction of the law, because it produces a state of things which is not only injurious to individuals, but injurious to the public health. Whether or not it is exactly the case prescribed by any of the Public Health Acts, I cannot say; but it does not appear that the difficulty has arisen upon that, but rather from the unwillingness, as I understand it, on the part of the Local Board to take any proceedings which should have an injurious effect upon any of its members.

3281. Under those circumstances, what controlling power would you bring to bear upon the Local Board?—That involves a question of forcing Local Boards to do their duty, and that is a question upon which the legislation of this country is very deficient indeed. An authority like a Local Board of Health is one of the most difficult to call to account for not doing its duty that can be conceived.

3282. You have paid great attention to this subject: can you suggest any controlling power under the circumstances which I have brought under your notice?—I think that for preventive purposes a control, such as has been suggested by the Noble Chairman, might be adopted. My opinion is that to take measures for the prevention of those inconveniencies, is by far the most promising course to adopt; but how far it is consistent with considerations of expense, and other questions, is a matter that would have to be determined by the different localities. I do not say that you could have a general law all over the country, that the people who should consider that they constitute the water-shed district, should form themselves into such district, elect a governing body, levy rates, and prosecute, by means of indictment, criminal information, action at law, or any other mode, persons whom they considered to be infringing the rights that they are employed to protect.

3283. Would you propose, under the circumstances, which have been brought under your notice, that a number of the ratepayers or inhabitants should have the power of petitioning a Central Board in London, that there should be an Inspector, or some other Public Officer, to examine on the spot, and that if the Local Board has neglected, or is neglecting its duty, what would you then propose?—The amount of interference that a Government Officer can exercise in such cases as that, is often very limited: he can report to his Board in London, and the Board in London, then, in some cases, might possibly have the power to send down orders; but no such authority as that is given in any of those Acts of Parliament relating to the Public Health.

3284. In the event of that power being given, will it not require another Act of Parliament?—Clearly so; there being nothing coming up to that point in the present Acts of Parliament, except in reference to the Salmon Fisheries.

3285. Is it your distinct opinion that further legislation is necessary to produce the result?—It is.

3286. Mr. *Cowper*.] Sanitary science and chemical analysis show that the admixture of town sewage with the river water which passes through a town, and is drunk by the inhabitants, is injurious to the health of the community, and yet it may be difficult to prove a mischief in particular cases; will the law of nuisance, as at present interpreted, prohibit the flow of sewage into a river,

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river, on account of the general effects which are alleged to arise to the health of the community?—I think that they were obliged, in all the instances that have ever occurred, to allege some special grievance. For instance, we find that in one case a man complains of the effect upon his fish; that is a vested right. Another complains that his cattle cannot drink of the stream. Another case might be put, in which the stream is rendered less fit for navigation, and in other cases the air about the place is injured; but all have some special grievance.

3287. Taking the case of London, and supposing that, instead of the Act which was passed for diverting the sewage out of London, an attempt had been made to use the law of nuisance for the purpose of dealing with it, do you think that there would have been any probability that proof could have been established that this sewage, which came into the Thames within the metropolis, was seriously interfering with the health of the community, and that it could have been established as such a nuisance as would justify the action of the courts of law in prohibiting the flow of sewage into the Thames?—I do not think it could have been carried into effect by any process of law whatever. I think that, even if there was a successful result of any legal discussion, it must still be an unproductive result. You cannot attack a nuisance of that magnitude, if it be a nuisance, by means of the law. You cannot put a sudden check upon things; it is beyond the pale of law. Even those much smaller cases, where private streams have been protected by the owners on the banks who have successfully prosecuted the Local Boards for injuring those streams, I believe in very few instances it has yet produced the desired result, so far as regards the actual purification of the stream, because the result is a thing that the law cannot produce; it prohibits the nuisance, but when the arrangements are such that you cannot stop them, it comes to a case beyond the power of the law to check.

3288. In the case where the sewage of a considerable district has been poured into a river, to protect it it would involve a very considerable expense in diverting the sewage elsewhere, and I understand you to state that there is not any practical remedy that would suffice to compel any parties to bear the very large expense that would be required in order to remove that nuisance; is that the case?—Not in so large a case as London; but a smaller case may be more manageable. Croydon you may consider to be amenable to the law, if, as is now stated, Croydon, by force of compulsion, has been compelled to adopt such measures. I say that is a manageable case.

3289. You stated that you did not think that lapse of time ought ever to be considered as sanctioning a nuisance; would you inform the Committee whether practically the existence of a nuisance which has been complained of for a long time, does throw a difficulty in the way of obtaining a remedy?—I think it does; it is a sort of paradox; but they have certainly brought forward this question of time as a justification of the nuisance.

3290. Could you fix any particular period of time that would be considered as bearing upon the question?—I think not, because the law says that it does not allow a nuisance; but in this case of the salmon fisheries, where the very facts upon which the jurisdiction arises are that the salmon are destroyed by the products which are thrown into the rivers, you still find the law saying that the party who causes that evil effect possibly does it in the exercise of a right.

3291. Would you consider that although this lapse of time does not justify a nuisance, it yet creates a right on the part of the person who produces that nuisance?—I think that it rather works as an "estoppel" against any person from complaining of a nuisance; it debars him.

3292. Supposing that a nuisance had begun within 30 years, do you think that then the remarks which you have just made would apply?—I think that the amount of time is not of essence in it. I conceive that the proper understanding of the law would be that the so-called right is a right to prevent the active interference of given individuals, A, B, C, or D, because they, by certain acts of themselves or their predecessors, are debarred; but how could that law ever be extended to the case of poisoning the fish in rivers? It is a thing that does not appear to me to square with the old definitions of the law.

3293. Supposing the case of house sewage which has been pumped into a river for a considerable time, and that the sewage that passes through that sewer is very greatly increased in amount, and that what was before comparatively innocuous became pernicious, do you think that that would be a case of difficulty to deal with?—That makes the case easier to some extent. They put that case strongly against the Local Boards; they say you have adopted contrivances and expedients here which concentrate this nuisance, and render it a totally different thing from what it was at the time when you say you had individual rights of discharging superfluous waters which were, in effect, nuisances. It has been held in those cases that the Local Board has no such right to concentrate the nuisance.

3294. Mr. *Adderley*.] You seem to say very naturally that even an injunction from the Court of Chancery cannot compel a party to do an impossibility?—No; there is a great difficulty.

3295. An injunction can only compel them to take all practical means to stop a nuisance?—Just so.

3296. But, in taking all those practical means, they must not be stopped by expense?—The expense is not an element in the judgment of the Court; but the right is considered to be inestimable, and the expense which the parties must be obliged to incur, in order to avoid injury to that right, is quite beside the question.

3297. Are you of opinion that the course which should be taken is not so much to facilitate remedies as to facilitate preventive measures?—Clearly.

3298. Supposing that the remedy which large towns were to consider the best were to carry the sewage through pipes to great distances, what legal power would it be necessary to obtain from Parliament to enable such a process to be carried out?—I think that the least powers would be those given by the Main Drainage Act for London, under which they have power to go 14 or 20 miles from London.

3299. Do you think that a similar power to the Metropolitan Act being extended to other towns throughout the country would give them all the

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power that is necessary?—I rather think it would not. I think that that scheme is very defective.

3300. Would you state to the Committee in what points that scheme is defective?—I think that, if it were worked out to do good to the population of the country generally, and not merely to shift a nuisance from one man's door to his neighbour's, it would be requisite to find some ultimate mode of disposing of the substance. The drainage of London is simply a contrivance to carry the products of the sewage where, according to the language of the Act of Parliament, it shall not open in or near the Metropolis. Anywhere else they may go, whatever the consequences may be; that would do for London, but it would not do elsewhere.

3301. What are the special powers of that Act for making an outfall through other people's property?—They have powers to carry their works all through in the same way that you could take private drains and sewers through individual properties under the Local Government Act or the Local Health Act.

3302. Would the powers for making an outfall in the Local Health Act, if extended, be sufficient for towns to carry the sewage to a distance?—They would require a very considerable extension and a complete set of new provisions, I think.

3303. Would they be similar provisions, but on a more extended scale?—On a very extended scale, and with a view to make an effective result of what is merely shadowed forth, as one may say. It is too general to be at all practicable to work upon in any way.

3304. Do you think that it would be a greater power than Parliament would be willing to give generally to all towns?—I think it would not be generally acceptable to have so general a power, which anybody might set in motion.

3305. But possibly for very large towns it might be a more admissible provision to give, even if it were not given generally?—I think it would. To large towns, and large rivers, it would be a boon to have some means of combining together to produce a result which would be beneficial to themselves.

3306. Would you state what are the powers of the Local Government Office to compel Local Boards to put a stop to nuisances?—They are almost *nil*, so far as regards anything they can do.

3307. And are the powers still less to compel Local Boards to stop committing nuisances themselves?—You cannot go to the Local Government Office for that; you must go to the Courts of Law.

3308. You seem to think, from your answers to the questions which have been lately put to you, that more power should be given to the Local Government Office to require the Local Boards to do their duty; is that your opinion?—I do not specify the Local Government Office; but I think that it would be necessary to have some authority to initiate the jurisdiction, the district area, and all the other particulars that would be requisite to create an effective jurisdiction; and that that jurisdiction, when in operation, should be amenable in several respects to a superior authority.

3309. Why should not the Local Boards be amenable to the Local Government Office?—The Local Government Office is now a department of the Home Office, consisting of a Secretary or some officer of that kind, and it cannot, therefore, exercise a judgment on those cases. It is not like the General Board of Health, which was a body of men who undertook to work out those things, and to find a remedy for the evils, and, having found that remedy, to enforce it.

3310. Why should not the Local Government Office, upon the report of an inspector, have power to act and compel Local Boards to do their duty?—Injured parties may say that there ought to be some jurisdiction, but the parties who would be affected thereby, such as trading manufacturers and others, who would want some means of having their case heard, would not acquiesce in such a powerful jurisdiction.

3311. I do not propose that the Local Government Office should have any jurisdiction in case of nuisances, but merely that it should set in motion bodies which exist and whose business it is to stop nuisances, and certainly to prevent them from creating nuisances; what is your view with regard to that?—I think that it would be a wholesome control, so far as my individual opinion is concerned, for all official bodies of that sort to be called to account.

3312. Of course the remedy or any question of fact or law would still go to the law courts. Does not the local government office, even now, through inspectors, to some extent, exercise a compulsory power over the local Boards to do their duty?—I am not aware that they do, and there are no cases in the books of indictments against local Boards at the prosecution of the Crown, or instigated by the Local Government Office for misfeasance, or nonfeasance, that is neglecting their duty.

Mr. ALDERMAN MECHI, called in; and Examined.

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3313. *Chairman.*] HAVE you been for many years in the habit of applying liquid manure to your land?—I have.

3314. Have you perceived any effect upon the springs and brooks which has been caused by the escape of the liquid into them after passing through the earth?—Very frequently.

3315. Is the land of which you are speaking drained?—The land is all drained at various depths, and no matter what the depth is, whether it is five feet, three feet, or four feet (for I have drained at all those depths), almost invariably, when we irrigate, we find that a portion of the sewage comes through into the brooks.

3316. Whatever are the quantities you put on the land; is that the case?—Even with the moderate quantity, which is our usual quantity, of a rainfall of an inch, or a hundred tons per acre, put on at one time, that is the case.

3317. Is it a very good soil?—It is a very stiff tile earth; a very great deal of it is too strong to make bricks of.

3318. And do you still find that some of the sewage escapes?—I do, and that the water comes through, frequently coloured by the sewage.

3319. What is the strength of that sewage, as compared with the sewage of London?—My own sewage is about one-third of the strength of the London

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London sewage, according to Professor Voelcker's examination of it; I sent him some down, and sent him down some of my soil, and he expressed surprise at its being comparatively so weak, but I frequently sow three cwt. of Peruvian guano, and two cwt. of salt, which, in fact, I am doing to day, and then wash it on with 100 tons of my own sewage, and even so late as last week, the weather being dry, I found that it had come through five feet drains, which are at intervals of 60 feet, and that it had completely coloured my pond, which is 100 yards long and six feet deep.

3320. Is it the sewage or the guano that colours the water that comes out of the drains?—Both will do it; but speaking of the condition in which I have seen the sewage of Croydon that is coming from the tanks filtered, I apprehend, from the condition in which I see it there, although I have not practically used it, that there will be but little colour after filtration through the soil.

3321. Is your sewage farm-yard sewage, or is it house drainage?—Our sewage is a combination of house drainage and farm-yard sewage.

3322. What is the colour of it when it comes out of the drains?—The colour varies with circumstances; it is either the colour of strong tea or of tea not quite so strong.

3323. You have seen, have you not, the London sewage?—Yes.

3324. Is that the colour of tea, or is it not just like very slightly muddied water?—The London sewage is less coloured than our sewage.

3325. Then there is some colouring matter in your sewage, is there not, which there is not in the London sewage?—We liquify all the solid manure of our animals by a great quantity of water, and therefore the colouring matter in that forms part of the sewage. I apprehend, in fact I am sure, that the more liquid portion would not produce so colourable a result.

3326. Then, if the mere London sewage were applied to land, after passing through the ground, it is not conclusively proved from your experiments that the brooks would be polluted by it?—I think that if, as is generally done, the solid portion were strained through gravel, and through perforated iron plates, the residuum of the liquid would certainly not come through the soil with any material, or any colour. That is my opinion, speaking from experience.

3327. Have you observed whether the sewage is more coloured with a very ample dressing than with a very small dressing?—Undoubtedly.

3328. And if you have given frequent dressings, would it be more coloured than it was at first, before so many dressings?—No doubt; the greater the quantity that you put on, provided there is colour in the material, the more likely you are to have an indication of that colour.

3329. Then does it appear that the soil does abstract this matter from the sewage, and keeps it there?—It does abstract a considerable portion, but not the whole; the colouring matter is only partially retained by the soil.

3330. And if there is too much of it put on, the soil has more of it than it can abstract, and, therefore, much does not remain behind in the soil, but runs through?—The more you put on the more colour, and the more nuisance you will be likely to have.

3331. And would not the rivers be more polluted by it?—I have observed the same effect on common farmyard manure after a rainfall when applied to the land; I have seen it come through from a dung heap on a very strong piece of clay, when heavy rains have fallen, so thick that it has been more like treacle than anything else; it has been much more highly coloured than I have stated, and has caused a nuisance for a mile down the brooks; and, in fact, when land is dressed with dry manure, such as soot and guano, and common farmyard manure, I have constantly seen very highly coloured liquid percolating through the drains.

3332. Then if the dressings are not too great, the brooks are not so likely to get polluted; is that so?—Certainly not, and I attach great importance to the filtration which is practised by most Boards of Health; they abstract the solid material and colouring matter before the fluid is allowed to go on to the land.

3333. Do you apply the sewage by hose and jet, or by gutters?—By hose and jet.

3334. Do you think that that is the best mode of applying it?—I think that in an undulating country it is the most profitable mode; the crops are better, and it is more evenly distributed; the liquid does not sink down into any sandy vein and escape, as it would be apt to do in gutters. I have known it disappear in its transit through some of those veins which occur in most soils, and you lose a considerable portion of that which should be distributed equally over the surface.

3335. Then, in fact, by the gutters the streams are more likely to be polluted than by the hose and jet; is not that so?—No doubt.

3336. And the hose and jet system of distribution is more valuable in an agricultural point of view?—Certainly, if you were putting anything valuable on the land.

3337. You do attach value to the sewage, do you not?—Certainly. Perhaps I may be allowed to state that I attach great value to water alone, which I frequently use without manure as dressing on the grass land. In summer weather, when we have cut a heavy crop of grass, our desire is to have moisture to make it grow again; and when I have an insufficient quantity of our own sewage, which is frequently the case, I sow 3 cwt. of guano per acre, and 2 cwt. of salt, and I positively charge myself with 2 *d.* a ton to put on 100 tons of pure water, for the purpose of washing in the guano and the salt, and it pays me to do so, because, as the Committee are well aware, dry manure is of no value; it is only when it is washed in by the rainfall (which amounts to 2,600 tons per acre per annum, as an average in this country) that it has its value; but unfortunately, in the summer time, when we have the sun to make a rapid growth, we are frequently without the water to use with the manure, and in that case it pays me to put on water at an expense of 2 *d.* per ton.

3338. Do you only apply this sewage to grass or to other crops also?—Principally to grass; sometimes to clover and sometimes to cabbages. In fact, my experience has taught me that it is good for every crop; but when we can get good grass and break it up after two years' growth, we then consider that the land is in a condition to carry a number of cereal and other crops, and that is my practice.

3339. Is it not the practice with common farmyard dung to manure the green crops, and then not to manure the ground for the crop of wheat that succeeds?—Just so.

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3340. The wheat feeds upon the manure that you put in for the green crops, does it not?—Yes.

3341. Is not that the foundation of the system of rotation?—Yes; it is especially so in the case of beans.

3342. Would you act in the same way in the case of sewage?—I would apply it to the green crops, but particularly to the grass crops in preparation for the following grain crops.

3343. Would you not apply it to grain crops?—Not unless I desired to grow grain crops every year. If I desired to grow grain crops every year, nothing would be more desirable than the application of town sewage. If it is applied to a grain crop that requires assistance it will enlarge and improve that crop very considerably.

3344. With regard to the fluid which escapes being coloured, is that because the soil is already charged with manure, or how do you account for it?—Professor Voelcker tried it with my own soil, which is a clay; he put a certain number of grains with 20,000 grains of earth and mixed them together, and soaked the earth with the liquid, but it failed to take out all the good elements.

3345. Is it then something peculiar in your soil?—I believe the soils vary much in their power of retaining all the manure, but we know that it is possible by the practice of water companies absolutely to take out within a certain number of grains every impurity from water. It would be exceedingly desirable for agriculturists that they should lose none of their valuable manure, for it is very costly, but, by the ordinary process of farming, I find practically that that cannot be done, and that we lose a great deal of valuable manure.

3346. Then, do soils differ in their power of abstracting the valuable matter from sewage?—They do, but I have not seen a soil yet which will retain it all.

3347. Then, the amount that would escape into the rivers from different soils varies?—Yes; and I think that the depth of the drains has something to do with it.

3348. What quantity of sewage would you apply per acre so as not to pollute the streams?—We think that for grass land we ought not to put on less than 100 tons at each dressing; and there should be about four dressings a year on grass land, and sometimes five, according to the season.

3349. When you do that, do you observe that, after the application of a quantity, the water that runs out is coloured?—It depends a good deal upon the state of the land; when the land is very dry it retains, of course, more fluid matter, like a bit of blotting-paper, which will contain more water when dry than when it is thoroughly saturated; when it is thoroughly saturated, putting more water on it would naturally cause it to run more freely. The earth has only a power of arresting a certain and a considerable portion of the valuable part of the manure.

3350. Do you think that farmers would be likely to take the sewage, generally?—I think they would, for this reason. The cost of putting iron pipes on my farm of 170 acres, so that every part of the 170 acres can be dressed with liquid manure, is 2 *l.* or a fraction over 2 *l.* per acre; and that is entirely irrespective of tanks or steam-engines. Therefore, the interest of that 2 *l.* at 10 per cent. would be probably the charge for that investment. If sewage from London or from a town were brought near my farm, I would immediately connect my pipes with it; because I have now not only to make my own sewage, at great cost, by feeding animals at a loss, but I have also to make tanks as a receptacle for it, and I have also to employ steam-power at considerable cost to force this sewage on to my fields. But if that line of pipes were connected with a main pipe, having a considerable pressure, which it would have from the elevation to which the liquid would be pumped, I should have nothing to do but to attach my gutter or hose at the end of one of the hydrants, and forthwith we should have our jet without the expense either of steam-power or of tanks, which add 2 *l.* per acre to the cost, and add so much beside for the working expenses of pumping it on.

3351. Then do you think that farmers would find it worth their while to take regular supplies of sewage, even if they paid 2 *d.* a ton for it?—Even if they paid 2½ *d.* or 3 *d.* a ton; because if it suits me, at certain seasons during the summer when there is growth, to pay 2 *d.* a ton for water to wash in the guano, which does answer, it would answer to pay (although we should like to have it cheaper) from 2 *d.* to 3 *d.* per ton for sewage.

3352. If there were works erected to distribute the sewage, you think that there would be no risk of that sewage being refused by the farmers?—Certainly not; but it must be by degrees that the people would come to use it. I would explain that in this way: the gentleman who took the Croydon sewage hesitated for a very long period whether he should give 5 *l.* an acre, having the command of the town sewage. He visited me; he went to Scotland, and he took a long time cautiously to consider whether it would be worth his while to pay 5 *l.* an acre for this sewage land. Mr. Cuthbert Johnson has stated and believes, that if that land which Mr. Marriage took four years ago at 5 *l.* per acre were now in the hands of the Board of Health of Croydon to re-let, they could let it for 15 *l.* an acre. That arises from the observation and from the conviction, that the produce is so large as to allow a profit over and above the 15 *l.* per acre; that is clear to everyone who knows the price at which the produce is sold, and who sees it cut. The same principle would apply to the farmers who first tried the sewage; one man would take some, and when it was found that it paid him to do so, there would be very little difficulty in persuading others to take it. Moreover, if I could have access to town sewage, instead of having only 15 acres of grass, which is all that I can find sewage for at present, I should have 50 acres, as that is a more profitable system of farming than by purchasing manure. It is simply a matter of cost, profit, and return; but, from 15 years' experience, I am perfectly satisfied that town sewage is the very thing we want, during the summer months particularly. With regard to the foulness of rivers, we must bear in mind that at present an enormous quantity of manure is washed down from the farmers' farm-yards during heavy rains; but I am also sure, from observation, that the more manure goes into a river, up to a certain point, the more rapidly will your weeds grow and exercise their purifying influence

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fluence in the river. The power of vegetation in the river is increased by the quantity of manure up to a certain point. The weeds appropriate the manure which they find in the water; they take it from the water, and not from the land, as the land plants do. Up to a certain point it is good; but beyond that you destroy the weeds and you destroy the fish.

3353. Do the fish also abstract some of the sewage, if it is not in too great a quantity?—I think that the purer the water is for the fish the better; but then they live upon the weeds. I have observed in my own ponds that, when the sewage comes in, after passing through the soil, it has had the effect of increasing the growth of the weeds enormously, so much so that they ran up in masses of six feet, probably, in the course of six weeks, with a certain temperature. And, again, we see up the Thames that, although the towns of Oxford, Reading, Windsor, and many others pour their sewage into the Thames, still the weeds grow the faster, and purify the water, and you literally see the fish and the weeds living well together; but when you get lower down the river, the dose is too strong, and you destroy your purifiers, and you poison the air and poison everything. Therefore, I do not anticipate that any evil would arise from moderate dressings of town sewage, after passing through the ordinary filters, when applied to the land. There is another reason, I would say, why 400 or 500 tons per acre would be a very considerable dressing. If I were to use guano, I should not use more than from 9 cwt. to 12 cwt. (at the very outside) per acre on my grass, and that would be equal, I suppose, to about 600 tons of sewage. I think they reckon a ton of guano to be equal to about 1,250 tons of sewage, varying, of course, with circumstances.

3354. Mr. *Ferrand.*] You apply the sewage to your farm by jet and hose, do you not?—By jet and hose.

3355. Do you see any objection to the surface application of it by open drains?—Not the least, excepting such as I have described, that you may lose some of it.

3356. But if the sewage of a large town was conveyed two or three miles into the country, and passed through large farms, would there be anything to prevent the farmer from taking the sewage and applying it generally over his land by drains opened with the plough?—Not the least; it would be a very inexpensive mode of doing it, and then he would want no pipes and no labour.

3357. Is there any case in which you have seen it done?—I have seen it done very often, and it has been very successful.

3358. Do you use any artificial manures besides guano?—Phosphate of lime; dissolved bones.

3359. Is it your opinion that there is a great amount of adulteration in artificial manures?—We all know that, unless you go to the right place, there is a class of people who sell inferior manures, and, unfortunately, many farmers are very much victimised. But we endeavour, by the aid of chemistry, to get what is pure and good.

3360. Is it not the practice now to boil bones for a consderable length of time before they are sold?—They are better for having the fat taken out of them, because they are more available to the plant.

3361. But what is the difference in price between buying ½-inch bones that have not been boiled, and those that have been boiled?—Probably you would get two guineas' worth of fat out of a ton of bones by careful boiling, so that that would be the result.

3362. Do you consider, as a practical farmer, that bones are better for farming purposes after they have lost two guineas' worth of fat?—Yes; it has been proved that they come into action more readily without the fat. If time is not an element, they would be better with the fat, because that would decompose; but as time is money in farming, you want a rapid action.

3363. If I were to tell you that I had applied a ton of bones that had been boiled, and a ton of bones that had not been boiled, to the same quantity of land growing turnips, and that I found that the turnips from the bones which had not been boiled were heavier in the crops than the others, does not that contradict the statement that you have made?—I should believe it if the Honourable Member said so, and that would shake my opinion as to the accepted fact.

3364. Have you seen any filtering works in play in towns?—Yes, I have.

3365. Will you describe what they were, and how they were carried out?—I saw those at Croydon; if my memory serves me there were perforated iron plates, with a bed of gravel between them, and the sewage was brought through those into more gravel, having left the paper and the solid matter behind.

3366. Do you know the breadth of the gravel?—I could not give you the details.

3367. Could you state how many layers of gravel there were?—I could not, but I think those facts could be easily ascertained.

3368. What would be the effect upon the sewage after it had passed through that gravel?—It would be dirty water.

3369. It looked like dirty water?—It looked like dirty water, and was slightly disagreeable to the smell.

3370. Will not a light soil cleanse the sewage much more than heavy clay land?—I think that very fine sand would be apt to cleanse it better, but it would not retain so much of its fertilising properties.

3371. That is to say, the sewage would pass through light soil more rapidly than through a clay soil?—Yes, it would, and there are no cracks in sand; sometimes we have cracks in our clay land. Speaking, as a landlord, of my own property, my land has been very quickly improved in value by the application of sewage. A pasture opposite my house, which certainly would not have let for 2 *l.* an acre, has by half-a-dozen years' sewaging become readily letable, if I chose to let it, at 5 *l.* an acre; that is on a stiff clay. I am sure, from my practical observation, that the application of town sewage would very quickly, as the leases fall out, raise very considerably the rent of the land.

3372. Mr. *Tite.*] Then must you not give the means of continuing the sewaging process, if you got 5 *l.* an acre for the pasture-field you alluded to; do you imagine that a farmer would take it at 5 *l.* an acre, and take his chance of being able to manure it?—I infer that he would have the means of continuing the fertilisation; but, independently

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pendently of that, the value of the land would be increased for a considerable number of years, probably seven years.

3373. Mr. *Ferrand.*] You alluded to the sewage passing into a pond, on your property, in a coloured state; how far was that pond from the hose and jet by which the sewage was applied?—About one-third of a mile.

3374. Had the sewage run the whole way over the surface of the ground, or had it sunk into the ground and come up again?—It came through drains, which are five feet deep, and then it found its way into a ditch, and then came into my pond.

3375. Do not you think that by applying the sewage by open drains on the surface, and the sewage passing through the earth, it would become purified before it reached your pond more than it does now by being applied underground, through drains?—I apply it on the top, and it falls like a shower. The way we apply it with a hose and jet is exactly like the operation of a fire-engine; 100 gallons per minute are distributed. The sewage sinks into the soil, and then it finds its way down precisely like a rainfall; it filters through the soil and into the drain-pipes.

3376. Mr. *Tite.*] Is it a deep drainage?—It is a deep drainage.

3377. Mr. *Ferrand.*] Would it not become more purified by running merely under the surface, and sinking through, without having tiles underneath?—Irrigation would be injurious without drainage, natural or artificial, because it would make wet land wetter still.

3378. But does not that depend upon the quality of the soil?—Where it is naturally or artificially undrained, then the addition of water or sewage would be an evil; it is only when it can sink through the soil that it is beneficial.

3379. But is there not a great quantity of land in England that does not require any drainage at all?—That is what I call naturally drained; on that land the sewage might run over and be distributed, and ultimately it must go through.

3380. But in all probability it would run off that ground in a perfectly pure state, would it not?—I do not think so.

3381. But would not that depend upon the distance?—Yes; the greater the distance, and the deeper the soil, it must ultimately go through that soil if it is to benefit it. It would not benefit the soil by running over the top.

3382. But still there must be large quantities of land in this country to which you might apply sewage at such a distance from streams of water or ditches that they may be perfectly free from pollution?—I quite believe that the whole of the London sewage, if applied in moderate quantities, might be used in agriculture without public inconvenience, but the area must of course be suitable.

3383. The colouring of the water would depend very much upon the soil and the distance to the drains and ditches?—Yes; but still, from what I have observed at Croydon, having made a preliminary filter of the sewage, it is then in such a condition as not to create any nuisance, unless it is applied in great excess.

3384. You have stated that, in your opinion, liquid manure may be applied with advantage to cattle crops?—No doubt.

3385. Have you tried it for mangel wurtzel?—Yes.

3386. Has it answered?—Yes.

3387. Have you tried it with turnips and potatoes?—I have tried it on every crop that I know is grown, and science tells us that it must be advantageous.

3388. Might it not be applied with great advantage to market gardens?—Certainly, where they wanted manure; but their quantities of manure are very excessive from the town. I know, in fact, that their manure runs like treacle through the drains, and I suppose that it all goes down to the river, it must go down to the river, in fact.

3389. Of what breadth are your iron pipes?—Three inches in diameter.

3390. Do you find that they corrode; have you examined the interior of them since you have used them?—Yes; the pressure is so considerable that it cleanses them and fills the pores.

3391. They do not burst, do they?—Excepting a pinhole that has rusted from the outside; the danger to be apprehended, if any, is from the oxydisation of the pipe from without, and not from anything that takes place within.

3392. Sir *William Russell.*] Do you think that it would be possible to take that town sewage in the winter months as well as in the summer months?—With the exception of very hard frosts, I think it would.

3393. Do you think that in the wet weather it would be of advantage to the crops?—I am sure it would, on this principle, that the earth has the power to abstract, at all times, a considerable portion of the best elements of the sewage.

3394. In what quantities have you ever put the sewage on to corn crops?—Very carefully, or we should force them too much; I should say not more than 50 tons an acre, or a rainfall of half an inch, and I think that is even more than we have dared to put upon corn crops.

3395. In how many dressings has it been put?—One single dressing in the spring.

3396. And it has not been repeated?—It has not been repeated; but for the sake of the ground itself, I would rather put a lighter dressing; I would rather dress it twice; in fact, we know that light dressings are good for cereals, much as a nice shower of rain is good for them, only that the sewage dressings are saturated with good things.

3397. With regard to your turnip crops, to what extent have you put the sewage upon them?—More abundantly. There is only this difficulty about a turnip crop, that the turnips are sometimes in the way if they grow to a certain size. I have irrigated them at various stages of their growth; but when you do it with a hose and jet you damage some of your turnips; but the gain is infinitely greater on the whole crop than the loss by a few score of turnips, although it looks rather slovenly. But I prefer getting good grass for two years, and plenty of hay from it, and feeding plenty of stock upon it, and then I am in a condition for three or four crops of any sort, whether cereal crops, or turnips, or anything else.

3398. Then you do not grow permanent grasses, but merely grasses that you break up?—I have some permanent grasses, which are very useful, and some Italian rye-grass, which is such a rapid grower, such a quick appropriator, and makes so large a return, that it is a great favourite with us.

3399. Having had your land, we will suppose, for

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for two years in grass, and having dressed it very heavily with this liquid manure, do you break it up for the purpose of putting oats or barley or some corn crop on it?—Yes.

3400. Do you believe that the manure has been actually absorbed by the grass during the two years that the land has been in grass, or do you find any results from it in the same way as from farmyard manure, the use of which on grass land is the best preparation for a subsequent crop?—Yes.

3401. Does the manure in that form leave a result in the grass land just in the same way as the farmyard manure does?—Most decidedly; in fact, we wish we had all grass land. We are sure of an abundant crop on grass land after putting sewage on it.

3402. Mr. *Ferrand.*] When you have had two years of sewage, and have tilled the land very heavily with this sewage, do not you find that there is a quantity of tillage left in the soil for the cereal crops to feed upon?—Decidedly. And, in answer to the Honourable Baronet, I would say, that unsewageraged rye-grass is the worst possible preparation for a corn crop; because, after the first cutting, the ground is so dry that we cannot grow anything; but with sewage we get repeated crops of grass, we can feed a larger quantity of stock upon it, and when we break it up, we get fine pea or bean or oat crops from it without manure.

3403. Is a large quantity of manure left in the soil more than what was taken up by the grass?—Yes, and there are roots left by the grass itself.

3404. Sir *William Russell.*] In some of the evidence which has been given before the Committee, the statement has been made that the grass itself takes up the whole of the fertilising properties which are contained in the liquid manure, that the deposit actually left on the land is very trifling, and that the land, after many years, if broken up, is really not improved, but that each successive crop of grass took up the whole amount of manure, and that it was so absorbed; is that so in your judgment?—In that case, I presume that the crop had been constantly taken off, and that not any portion of it had been fed on the land; we feed a portion of our grass, we cut it in one year and feed it the next year, and keep 16½ sheep to the acre upon it.

3405. Then is it the manure of the animals that you feed upon it that affects it, and not the sewage?—I apprehend that they both affect it, for when I mowed it twice I found that the result was excellent.

3406. Mr. *Ferrand.*] What the Honourable Baronet wished to learn from you was this, whether, supposing you were to grow for two years in succession a crop of grass, and to take the whole of the grass off the land and eat it in your stables or elsewhere, and to saturate this grass land for two years with your sewage, eating none of the grass upon the land in the next following one or two years, and then growing cereal crops upon it, you have not found a large quantity of manure still left in the soil for the production of your corn crops?—I think I have always taken it off; I have generally cut it one year, and fed it the next year with stock.

3407. Then you cannot give any evidence on that point?—No; I do not think I can. I think that in some instances I have cut it twice partially, but it is not so good as when I have fed a part of it off. I am quite sure of one thing; namely, that the rye-grass takes out a great deal of the manure that is put on, and that after that it would be desirable possibly to irrigate the second or third crop. I do not think that the first crop would require it, and perhaps not the second; but a great deal would depend upon circumstances.

3408. Is not rye grass a very impoverishing crop to the land?—Without moisture it is, but not with plenty of moisture.

3409. But the moisture is the liquid manure, is it not?—I attach great importance to the rainfall.

3410. Mr. *Leader.*] You have stated that some of your permanent grass land was worth 2 *l.* an acre, and is now worth 5 *l.* an acre, and that the effect of the manuring continues for seven years afterwards; is that so?—Yes; I wish to state that I cut it off for hay, which was probably consumed on another part of the farm, and then I allow a crop to grow and feed it a second time; I feed it with cake. There is great value in this sewage; but if you take the crops off always, you must put another dressing on.

3411. But do you attribute the increased value of the land from 2 *l.* to 5 *l.* to the fact of its having been covered with sewage?—Yes; I think that the great value of the land depends upon the sewage.

3412. Do you still continue to use in a liquid form the bulk of the manure made on your farm?—I should do so; but we have so much straw that if I put my animals on sparred floors I should not get rid of the straw, otherwise I should use liquid manure entirely, because I am sure from my observation that solid manure liquified, with plenty of water, is a much more profitable investment than putting it on dry and waiting for the chance of rain. It is more evenly diffused; it is quicker in return, and it is more profitable.

3413. Can you state what is the cost to you of that liquified manure per ton?—I could not state that; I can only say that I pay 2 *d.* a ton for water in the summer season, and I have to produce my own manure at a loss from feeding the animals on cake and corn, which almost everybody does. Therefore, if I had a sewer which would convey the sewage on to my land, I should not lose money by feeding my cattle, but I should grow grass and feed them with the grass produced by the application of the sewage.

3414. Is it your evidence that the London sewage is three times as strong as your sewage?—Professor Voelcker made the analysis in the Society's journal, and showed that town manure was three times the strength of the manure which I sent him, which was the usual sewage that I use.

3415. Then is one ton of the London sewage worth three tons of yours?—Yes, unless I sow guano with it.

3416. Cannot you state how much per ton it costs you to make this manure?—I use an enormous quantity of water, and without an enormous quantity of water we could not carry out our operations. Fortunately I have a large spring drain, that gives me 40,000 gallons a day, and that is all consumed; I have to let it run all night long to get a sufficient supply. A great rainfall mixed with our manure is the source of the fertility of my soil.

3417. Mr. *Tite.*] What is the soil of your farm?—About two-thirds of my farm is clay land.

3418. You have applied the system of draining to your land thoroughly, have you not?—To the whole of it.

3419. Your drains are at the distance of a rod apart, are they not?—Yes.

3420. How deep are they?—They are at various depths; some of them are at a rod distance, and some which I cleared out adjoining, are at 50 feet distance; but I would state that those 50 feet drains are in strong clays, they are five feet deep, and I have found that the fluid runs down through that clay, colouring the brook.

3421. In your farm, you first conceived and then constructed a tank on the high land into which you carried the manure, and into that mass of manure you introduced water very extensively, did you not?—That is so.

3422. Then from the bottom of that tank you carried the sewage through a series of iron pipes to convenient points in the several fields, by pumping?—Yes, it is not above the level; the water runs from my great spring 12 feet to my tank below the level; the suction goes into it, and then the water is raised and then forced by plungers into the different parts of the farm.

3423. Then it is pumped into pipes which go into each portion of the farm, is it not?—Yes.

3424. And then by the ordinary means of a hose, like the hose of a fire-engine, it is distributed over the land in a shower, which is very fertilizing, but not very agreeable to the smell?—Our sewage is very offensive, for this reason: that the whole mass is allowed to accumulate in this tank, and undergo putrefaction. It sometimes remains a week in the tank, and, if it remains any length of time, it becomes offensive, from the sulphurretted hydrogen which is generated; but when we have washed it once or twice, and then let the water in, it is fresh. It makes all the difference whether it is fresh or whether it has undergone putrefaction.

3425. Do you find that this liquid manure never affects the pipes sensibly, and that the pipes are not choked by it?—No.

3426. Do you adopt any system of filtration for the purpose of preventing the pipes from being choked?—No; the pressure is so great that anything forced into it would be crushed. I believe that it would break every bone in my skin if that amount of pressure were applied.

3427. The following question was addressed to Mr. Cuthbert Johnson, by the Honourable Baronet the Member for Norwich: "Do you consider that the sewage itself is taken up by the crop almost entirely, and so goes off; or do you think that it enriches the land at all;" to which Mr. Johnson replies, "I think that the ammoniacal and soluble portions are chiefly taken up by the plant; and that the mechanically suspended matters, which are the most worthless part of the sewage, and which generally consist of a great deal of silica, and perhaps a little alumina, are deposited on the land, and we should be just as well pleased if it was not there." Do you agree with him in that, or is your opinion different from his?—I agree with him in this respect, that the deposit on the top of the land is what you would call the non-valuable portion of the manure, and that the suspended substances which are not soluble are comparatively of little value; that the soluble portions are valuable, but I do not agree that the bulk of them are taken up by the growing plant, unless under a particular stage of growth, where the fibres, as we know they do in some cases, form a fine white laced network over the whole of the surface in the vigour of their growth. You will find that in rye-grass sometimes the whole of the surface is a kind of white fibre, so that those fibres form a strainer and absorber at the same time.

3428. Then the examination of Mr. Johnson continues: "All the really fruitful properties are taken up by the actual crop, and there is no additional value to the soil itself, unless you can be continually applying sewage to it; is that so?—Exactly."?—I think that that is not the case, for the reason which I have stated, and I know, by Professor Voelcker's experiments, that an important portion of the soluble and valuable parts of the manure filter through the soil, and run away; I do not know whether the Committee have before them an analysis of that pure water that leaves Mr. Marriage's farm, because I am convinced, in my own mind (and I should like to see an official testing of it), that, though that water is as pure in appearance as spring water, it contains a large amount of soluble, but invisible and valuable material.

3429. There is an explanation, to a certain extent, in the next question, which was put by the Honourable Baronet: "That is to say, if you discontinue passing the sewage over the land, the land will return to its original value?" And this is the answer, "If the mechanically suspended matter of the sewage, which we say contains some silica or some carbonate of lime in considerable quantities with it, or alumina, is deposited in a soil which is naturally deficient in any of those three earths, then it permanently improves the soil by the deposit, but if it is deposited on a soil whose earthy matters are of a similar composition to the matters suspended in the sewage, then it does no good." In your case, would not carbonate of lime, alumina, or silica, be useful to the land itself?—Carbonate of lime, and alumina, we have plenty of, and plenty of silica also; but one important point, which is not touched upon there, is that the natural filtration of the water through the soil greatly improves it, by decomposing and preparing the soil itself; I will illustrate that, by stating that land, which I drained 20 years ago, by the mere filtration of water through it, year after year, is so far in advance of another field which I drained 10 years later, but which was still done 10 years since, that I can see the difference like a coloured map. Nothing that I can do to the field which has been drained for 10 years, but which still has been drained 10 years later than the other one, which has had 20 years of filtration through it, can bring that second field to an equality with the first.

3430. Sir *Frederick Smith.*] Was the soil exactly similar in those two cases?—The drill goes through them both; it is the same soil.

3431. Mr. *Tite.*] Do you attribute that to the deep drainage, or to the artificial manure?—I attribute it to a variety of circumstances. I attribute it to the aëration, or weathering of the soil; it has improved its physical and chemical condition.

3432. You state that, in your soil, carbonate of lime would be of great use, whereas in soil like that of Croydon, which is a light soil over a chalky substratum, it would be of no use; is that so?—That is so.

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3433. Sir *William Russell.*] With reference to the point of drainage, have your drains a connexion at the top, so as to have a free circulation of air through them, as well as for the process of passing the water?—They ought to have it, but they have not. If I had to do them again, I would have a free circulation of air.

3434. You would have the air entirely at the bottom, and passing out at the top?—Certainly.

3435. And do you believe that the circulation of air would do almost as much good as the filtration of the water?—I believe that the aëration of the subsoil is one of the most important questions in agriculture.

3436. Is it the case that the iron piping costs you 2 *l.* an acre, and that the pumping costs you 2 *l.* more?—For tanks, and so on, it costs 4 *l.* an acre, and if I had the connexion of my pipes with the sewage of London, I should invest 2 *l.* per acre less capital.

3437. Would the 2 *l.* be saved?—Yes, and I should be saved the very important item of coals and attendance for working the steam engine daily.

3438. What do you consider to be the expense of that?—I think it would save me 12 *s.* a day.

3439. How many acres can you pump over?—170; I can pump 150 tons a day on an acre and a half.

3440. That would be 12 *s.* for an acre and a half, would it not?—Yes; it would save me 8 *s.* an acre, besides the interest on the 2 *l.*

3441. That 8 *s.* an acre includes the maintenance of the engine and the labour cost, in fact, does it not?—Yes; but that is repeated four times, which would be 32 *s.*; the 8 *s.* is for each dressing, for coals, and for engine attendance.

3442. Mr. *Ferrand.*] Is it your opinion that the aëration of the land is increased by the application of sewage manure?—Undoubtedly, or by any fluids passing through drained land. The water displaces the air, and then the air passes upwards or outwards.

Lunæ, 13° *die Junii*, 1864.

MEMBERS PRESENT:

Mr. Adderley.
Mr. Sclater Booth.
Mr. Caird.
Mr. Ferrand.
Mr. Hibbert.
Mr. Leader.
Lord Robt. Montagu.
Sir Joseph Paxton.
Sir Frederic Smith.

LORD ROBERT MONTAGU, IN THE CHAIR.

HENRY W. ACLAND, Esq., M.D., F.R.S., called in; and Examined.

H. W. Acland, Esq., M.D., F.R.S.

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3443. *Chairman.*] You are Regius Professor of Medicine at Oxford, are you not?—I am.

3444. Have you not given a great deal of attention to the subject of the pollution of streams, and particularly of the Thames?—I have, especially as regards Oxford and that immediate district.

3445. You have stated in a book which you wrote, that you consider that "The condition of the Thames Valley is a national disgrace," is that still your opinion?—I see no reason for modifying it.

3446. The area of the catchment-basin of the Thames is 6,000 square miles, is it not?—It is from 5,000 to 6,000 square miles, I believe; it is stated to be 5,356 square miles, in the Second Report of the Sewage Commission.

3447. How do you mean that the condition of the Thames Valley is a national disgrace?—I think that it may be so called in two respects, especially; first of all, that no systematic means have been taken to hinder the pollution of the river; and, secondly, that no systematic means have been taken to hinder the frequent flooding, which is injurious to the inhabitants.

3448. The Isis and the Cherwell overflow constantly at Oxford, do they not?—Yes.

3489. Are not the cellars in many of the houses in Oxford flooded periodically?—Yes, under certain conditions, houses in some parts of the town have from one to two feet of water in the cellars, and this especially in the poorer districts.

3450. What is the effect upon the health of the inhabitants in the Thames Valley?—It is not very easy to state precisely what the effect on the health of the people from those various causes is. I have no doubt that, speaking generally, there is a certain deterioration produced in their condition, and that they suffer very much from a low state of constitution, which is engendered by damp as well as by other causes. Perhaps the Committee will permit me to say in the outset, that considerations of this kind were those which led me to inquire into the subject in a systematic and extensive manner; that is to say, I found that the people in my neighbourhood appeared to me to be in such a low state of health as to require quinine in many maladies. I found that many of the poorer parts of the town in which, many years ago, I went to reside, were injured by improper drainage. I further found (and this is very important) that, even although the town were properly drained in respect of its sewage, the subsoil and the ground, not only in the town but in its neighbourhood, were frequently saturated by the surface water. I saw that surface water flowed into the gravelly districts under the town and about it, and that from that cause, working in with the deficient sewerage, I have no doubt that the general health of the people suffered. Hence I was forced to look into the question of the Thames Valley, as a whole.

3451. You state that the cause of this flooding is the ponding back of the water of the Thames Valley, to a certain extent?—Yes, I think so; leaving, for the present, the sewage question, and keeping to what I suppose the Noble Lord's question refers, viz., the general sodden condition of the ground, or, as it was called the other day, the water-logged condition of many of the flat districts. I have no doubt that the evil depends in a great measure upon the water being stopped at certain places, which would be the natural outlets. Of such places I could give examples.

3452. Then do you think that obstructions have been formed in those outlets of the river, which were originally sufficient for the flow of the water?—That is an engineering question which, of course, it would not be proper for me to answer absolutely; but I have no doubt that is the case. All these valleys had natural outlets; and those outlets have been artificially diminished, and that which justifies us in finding fault is, that they are artificially diminished with no adequately good results, I believe, in the present day, at least, to anybody, while the evil might be very easily remedied.

3453. Do you refer to the obstructions caused by mill-dams?—There seem to be at least two great reasons for this condition of things; the one is the navigation works, and the other mill-dams; that is to say, the water has to be kept at a certain level, and, if that level gets, from any cause, above that which would clear the surrounding lands, of course the lands get sodden in the way which I have described.

3454. But, besides all that, is there not a great deposit of mud from town sewage?—Yes, locally there is.

3455. That would tend also to cause those floodings, would it not?—Both directly and indirectly; and I believe that in many parts of the Thames, high up the river, there is a considerable deposit, speaking generally; but, still, I do not know that there are observations to show that the

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course of the stream high up has been really materially diminished in depth; locally it has been; and I have seen within the last few days one spot especially, in Oxford, where the deposit of the sewage is stated to me, on a perfectly credible authority, namely, that of Mr. Taylor, a member of a large brewing firm, to be so large that, to his knowledge, in one place it has filled up to the depth of nearly six feet.

3456. If the sewage is discharged into the river, would not that putrifying matter make the damp much more unhealthy, when the river floods into the houses?—Yes; I suppose that there can be very little doubt of that where large deposits of sewage take place. A curious operation, which is probably well known to the Committee, takes place—namely, what the people call fermentation; that is, a disengagement of gas takes place at the bottom of the river, and large masses of black sewage which have been deposited are thrown up to the surface, and, being light, float upon the surface and are carried down, and then in course of time either those masses become disintegrated and generally dispersed through the water, or they get redeposited. In this way masses of human ordure or fæces are carried to considerable distances. My attention was called to this not very long since, because a complaint was made to me by a gentleman that on pulling down our river with some ladies he saw masses of human ordure floating down the river. I had not noticed this, and I thought it right to inquire into the fact, and I found that it was literally so. I have seen within the last few days considerable masses of such matter floating down the river, either independently or, which is worse, entangled in little masses of weed or rushes, or the like, which are swept away from the banks; to what distance those masses are carried I cannot say, but I am told by the boatmen that they will go down several miles. At all events, within the last few days, I have seen them one or two miles from Oxford myself in a perfectly unaltered condition and of considerable size, and floating down on masses of weed.

3457. In hot weather, would they not be very apt to putrify and infect the air as well as the water?—I think that is quite proved in various reports, which are, no doubt, as well known to the Committee as to myself. I think that there is not the slightest doubt that excrements from human habitations in the towns pollute the waters in a very dangerous manner. I think it is perfectly established by sanitary investigators that disease, especially cholera, has been propagated in this manner. I cannot for a moment doubt it; and therefore I have said enough to justify the observation, that considering this dangerous process is going on in a number of towns above the metropolis, and considering that we do not know how far the danger may be carried in the water, moreover, every desire not to exaggerate, it is desirable that steps should be taken to purify the whole stream up to its source or through the whole of the river basin. That is the argument.

3458. Did not a Local Committee of the town inquire into this evil with regard to Oxford, in the year 1853?—That is true; there have been several steps in this inquiry which some persons think to be independent one of the other; I have heard even lately that it is said that the question of the condition of the floods has nothing to do with the question of the disposal of the sewage. In that I do not agree, because I think that the remedy for the one is very intimately connected with the remedy for the other. The inquiries which the Noble Chairman refers to were conducted by Mr. Philip Pusey, the late Member for Berkshire, a person whose ability and industry in all matters affecting public interests in respect of agriculture, either directly or indirectly, are well known. That gentleman took great pains about the state of the Upper Thames, chiefly with respect to the inundations; and I have in my hand the report which was drawn up under his superintendence. Unhappily, not long afterwards he died.

3459. Do you consider that the remedy for floods and for the sewage flowing into the river would be the same?—I said that they were intimately connected; I do not think that it would be correct to say that they were the same. The kind of works that would bear upon one might be intimately connected with the works to bear upon the other. The inquiry by the Committee of 1853 was with regard to the removal of obstructions. Now, referring to the case of Oxford as an illustration, we find that about three miles below the town we have obstructions to the general surface or flood water, but at the very same point we find the point at which we ought to have the outfall for our sewage matter also. In that way, as well as in sanitary respects, the two are connected.

3460. Has not every attempt failed which they have made to remedy those evils?—Yes; we have hitherto failed from various causes.

3461. Could you relate shortly the causes of failure?—One of the causes is, I think, that really the best mode of disposal of sewage is even at the present moment not thoroughly understood; at all events, there has been great difference of opinion about it, and perhaps those who are most eager to bring the matter to a successful issue in our neighbourhood, are not confident as to the best course to recommend to the public. Then a second cause is, that we (so our surveyors tell us) have practically no power to enforce even the provisions which exist under certain acts of Parliament. And, thirdly, the land where we should get our outfall, and through works erected on which we should get rid of our flood-water, and to which we should carry our sewage, is in the hands of private persons, who are not disposed to give it to us; and as we have no power to compel them to sell it to us at present, we are at a dead lock.

3462. Do you think that the Government should take in hand the management of the whole of the catchment-basin of the Thames?—With the best attention that I have been able to bestow on the subject, I really cannot see how, in any river basin whatever, whether it be the Thames, or other basins (but I will speak only of the Thames as that which I am most acquainted), those evils are to be remedied, unless there is a general power of superintending and regulating the course of the waters, and of course a purification of the water. Accordingly, in a memorial which was presented to Sir George Grey two years ago, we used these words "*regulation* of the Thames waters," which I will explain.

3463. Would you be good enough to put that memorial in?—I will hand in the memorial to which I refer. (*The same was delivered in.*—Vide *Appendix.*)

3464. Do you think that until the Government has undertaken that *regulation* of the whole basin, Oxford will not be adequately drained,

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drained, nor the other towns in the basin, and that they will not reach their due point of salubrity?—The opinion which I formed of that matter, and which I still hold, is this: that if those waters are to be kept at their proper level, that is to say, neither too high nor too low (and it is nearly of as great consequence that they should not be allowed to run too low as that they should not be allowed to overflow), that must be done by a general power, to regulate the whole river from the source down to the outlet at Teddington. If we, for instance, were to get possession of the Sandford Mill, which is the chief cause of the floods which swamp us, the only result would be that we should pour down the water more rapidly upon the place immediately below. When I reflected on that point, a few years ago, I said that it was quite clear that what is wanted for the place above is wanted also for the place below, and so on, down to the mouth, and that as it could not be the business of any particular town to look after the whole basin, so it was the business of the Legislature to do so.

3465. So that one town might not affect the waters below it?—Certainly.

3466. Might not that plan interfere with some private interests, and perhaps with some local convenience?—No doubt. Proprietors are sometimes of that opinion, and in many cases that opinion would be really well-founded; but from what we can learn from engineers and other persons skilled in such inquiries, I believe that the mischief to private property that would be done by a proper regulation of the Thames water would be very much less than is supposed. In the case of Sandford, we believe, most conscientiously, that it would do no injury to property whatever, because all that we want is to have such an outlet as will hinder the water from ever rising above a certain level; and supposing that outlet is at a proper level for the interests of the proprietors, I cannot see how it could hurt their rightful interests at all.

3467. But, in any way, you would conceive that private interests or local convenience should give way to the welfare of the inhabitants of the whole of the catchment-basin?—There is no doubt that this is a constitutional question, and that it is a very hard thing that one man should be able to swamp 25,000, with, after all, little advantage to himself.

3468. If the sewage, instead of being allowed to flow into the water and polluting it, was applied to the land, would it not be a great benefit, by reason of the greater supply of food that would be thereby produced?—Seven or eight years ago, when I wrote the essay to which your Lordship has referred, I suppose that was an universal opinion; but subsequent inquiries appear much to have modified that; that is to say, that although, generally speaking, some portions of sewage are exceedingly valuable, yet, as will appear in many reports which I have, the opinion as to the high value of sewage is considerably modified. That appears, for instance, in Professor Way's evidence, in the First Report of the last Select Committee of the House of Commons of 1862, and also from Professor Voelcker's evidence; not that I would wish to give a chemical or an agricultural opinion upon that point. I merely speak from what I have read and what I have learnt. But I take it that the opinion as to the high value of sewage is considerably modified.

3469. Do you mean that it is a question open to doubt?—It is a question open to no doubt, apparently, on some soils, under given conditions, but it is open to considerable doubt as to its high value in others; that is how I understand the evidence.

3470. In order to carry out this remedy, which you have mentioned, as to the regulation of the whole of the catchment-basin, do you think that any fresh powers would be required?—I am informed by our legal advisers that the powers at present are either insufficient, or so difficult to be put into operation, that, practically, fresh legislation is absolutely necessary.

3471. In this memorial which you have put in, you state that you desire that some systematic provision should be made for regulating the several branches of the waters of the Thames Basin on a common plan, and that that would greatly abate the evils which are complained of; are those the only fresh powers which you would require, namely, that there should be some common plan of arrangement or regulation?—I do not think that I should express an opinion upon that point; my opinion as to that is based entirely on the information which I receive from other persons. With respect to the Thames Valley, it is, I understand, a very complicated legal question. There are many old Acts and powers relating to navigation which would complicate it very much, and upon which it would be wrong for me to give an opinion.

3472. If I understand you rightly, the first requisite is unity of action throughout the whole of the catchment-basin, so that one town should not pollute the water while another town diverts the sewage from the water, and yet suffers from the action of the town above?—Certainly.

3473. Supposing that the Local Government Act, instead of being applied to each town severally, were applied to the whole of the catchment-basin, and that the powers which are now given to the local board of the town were extended to the whole of the catchment-basin, do you think that that would meet the difficulty?—Whether that would be the best machinery or not I cannot say; but speaking of the Thames itself, and not referring to other rivers, the first requisite appeared to me to be to have a report upon the actual condition of the evils and obstructions that existed, together with suggestions as to the remedies required; and I believe, as I stated just now, that those remedies would be much simpler and much less injurious to private persons than is generally supposed. In the course of such an inquiry, if that inquiry were conducted by competent persons, advised by engineers and lawyers, what is required to be done would really appear, and what would be the best machinery for carrying it out (whether by the Local Government Act, or otherwise) would also appear. But the Thames Valley is so conveniently situated, with regard to London, so accessible, and so well known, that it would be very easy to get an opinion from a Government engineer as to what was requisite, and as to what would be the best way of carrying what was required into effect.

3474. Are you aware whether filtration would clear the water of pollution, so that it would be no longer dangerous or injurious to the health of persons drinking it?—I am not aware whether the experiments that have been conducted on this subject would justify me in saying that; I am not aware, as I stated just now, to what distance, and exactly under what circumstances, water may be

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be considered perfectly safe when once it has been rendered dangerous to health, by evacuations, or the like. I could not give a positive opinion upon that point.

3475. Might not what is imperceptible to the eye in water very easily breed serious epidemics?—Whatever be the cause of cholera, it is certainly not visible to the naked eye.

3476 But could not water that to all appearance was perfectly pure, under certain circumstances, breed epidemics?—I cannot say, positively.

3477. You do not state that it is not the case?—No; there is, by Dr. Dundas Thomson, Dr. Hassall, and other persons in London and elsewhere, very strong evidence to show that the cholera is carried by water; nor can I say what degree of dilution will remove such poison once communicated to the water.

3478. Are not typhoid fevers also bred by impurities in water?—It is so stated.

3479. Supposing that the present laws were sufficient to prevent the sewage from being put into rivers, does not the difficulty lie in this: that there is no one whose duty it is to enforce those laws?—I am not aware that it is anybody's duty at present.

3480. If the Local Government Act were adopted for the whole catchment-basin, would there then be some one whose duty it would be to bring actions or indictments against those who infringed the laws?—I conceive that under that Act it would be the duty of the Board to do the utmost that it could for the health of the district, under the great powers which it would possess; and if those things were injurious, it would be their duty to endeavour to abate them.

3481. If it were injurious to health to allow this sewage to run into the river, must not those boards have power to erect works to carry it elsewhere, on to the land for instance?—That would be quite requisite.

3482. Did not you state in your book that you consider that a stock of fish tends to keep the river pure?—Several years ago, at the time when I was making those inquiries, I was struck by this fact, which I have noticed repeatedly since, and which indeed I have noticed this week: that some fishes (minnows first of all, and various larger common river-fish) accumulate round the mouths of some of the sewers, and make them their great feeding grounds. It is very well known that there are arrangements in nature of that kind for the supply of food for various animals, which then prey upon one another. At all events, I have noticed repeatedly near the mouths of our sewers shoals of small fish feeding.

3483. Do you consider that they tend to keep the river pure?—If they convert, in the ascending series of organic matter, those putrefying excrements into healthy life, of course they do so *pro tanto.*

3484. If the river is rendered noxious by the sewage, does it not kill the fish, and thereby destroy the natural remedy for the evil?—The fish have then no chance.

3485. You consider that there are two reasons for not allowing the sewage to fall into the river: first, because it pollutes and contaminates the stream, and, secondly, because it produces a loss of those elements of reproduction which you say should move in a continuous cycle?—Certainly; there is no doubt about either of those facts.

3486. Those matters should be transformed, first into plants, and then again into the flesh of animals?—Certainly.

3487. Is it not necessary to remove all organic refuse at once from houses by some means?—It ought to be, of course, immediately removed in some manner.

3488. If it remains in the houses, would it not tend not only to produce pestilence, but also to rob the land of a fertilising agent, which it should receive?—Without doubt the injurious effect of cesspools (which are, according to the old English arrangements, the ordinary means of retaining those excrements within the precincts of the house), and the evils attending them, as constructed in the old way, cannot be exaggerated; in fact, I think that they can hardly be stated sufficiently strongly.

3489. Do you consider that the refuse should be removed from the houses by means of an ample water-supply, and sewers and drains?—Speaking generally, and with respect to large towns, I do not doubt that at all; but I would not wish to go the length of saying that that is of universal application, because I do not think it could be so.

3490. There are some cesspools in Oxford, are there not?—I am afraid there are a great many. The town was just one of those old towns in which, until the last few years, the modern system of drainage was not at all applied as in other towns; and being a very old town, part of our soil was literally riddled with those cesspools. I know a small garden in one of the best streets from which the occupier has removed, within the last few years, as many as five large cesspools. One of these was 17 or 18 feet deep; it had been closed over; others had been made in proximity to it. Now, of course, in places where cesspools are in the neighbourhood of floods, the water would wash through such cesspools and contaminate the wells.

3491. Are the contents of those cesspools carted away to a distance of 15 miles from Oxford, and utilised on the land?—I have not made any recent inquiries on that subject, but no doubt they are so now. Formerly that was the way in which, practically, the town was cleansed by nightmen.

3492. Do they cover the expenses of carting it to a distance of 15 miles from the town?—It has been frequently argued that the manure was valuable because that was done, but it must be borne in mind, of course, that those scavengers were first highly paid for removing it from the houses; so that if they could get ever such a trifle from the farmers for it, it was so much more than they had already received in full payment for the act of removal.

3493. It has been stated in evidence before the Committee that it is cheaper to carry such matters in suspension in water than to put them in carts and cart them away; do you concur in that opinion?—I conclude that it is so, certainly.

3494. Then, in fact, would it not be better and cheaper to utilize this sewage in a liquid state than to cart it to a distance of 15 miles?—I do not wish to pledge myself to questions of an engineering or agricultural kind any further than what I can collect from documents which are accessible to all persons; but I may say that my opinion as to that is, that it depends very much upon the amount of dilution which the manure is subjected to and the nature of the soil on which it can be deposited. The condition of the sewage is not the same in all towns, and therefore one must be careful not to make a positive statement concerning the question as a whole, which may be true of one place, and not true of another.

3495. When once the sewage is dissolved in a volume of water, is it not useless to extract it; do you not lose the most valuable parts if you try to extract a portion of it?—Economically and commercially that would be so; a large portion of the most valuable part of the manure, as manure, is really contained in it when in solution or suspension in water.

3496. Then if it be utilised at all would it not be better that it should be utilised in the liquid state?—Unquestionably.

3497. Then does it not come to this, that if you have a water supply in a town, and may not put the sewage into the river, the best thing that you can do is to put it on the land?—I presume so.

3498. In any case, for sanitary purposes, it must not be put into the water?—Certainly not; the most harmless way of disposing of it, according to the present condition of our knowledge, is by spreading it over the land.

3499. You proposed in your book, did you not, to pump the sewage of Oxford up to a hill near Bagley Wood, and then to let it gravitate over the land?—That was a proposition in my original essay. I stated it to be an engineering question, and a question also as to whether it could be done profitably; but since that time a good deal of light has been thrown upon the mode of disposal of the sewage, and upon the economical considerations which attend it; for instance, it appears that the land requires a much greater quantity of sewage to be really useful to it than was formerly supposed, that is to say, less land is requisite for a given amount of sewage. In Oxford we have not sloping lands that might be supplied with the sewage of the town, without pumping, till we get somewhat lower down the river.

3500. Are you speaking from a knowledge of the facts, or from books which you have read upon the subject?—I took the opinion as to that special point as regards Oxford several years ago from Mr. Lawes.

3501. Is that the gentleman who has carried on these experiments at Rugby?—Yes.

3502. Are you aware that it was stated a few days ago that Mr. Lawes considers that those experiments, as detailed in the report of the Commission, are utterly delusive, and that they would mislead the public?—I was not aware of that.

3503. If I understand you rightly, the conclusion at which you would arrive is this, that the Government should undertake the regulation of the whole of the catchment-basin of the Thames, and that the sewage of the towns should be used for irrigation, and that attention should be given to the breeding of fish in the rivers, in order to purify them?—That would generally express my opinion.

3504. Mr. *Hibbert.*] You have stated that human excrements are very often seen floating in the river, at Oxford; are there privies in the town which are open to and connected with the river?—Some of them are. I suppose there are still privies at the backs of streams which are open.

3505. Are not some of the college privies connected with the river?—The improvements that have taken place in the town have been so great within the last few years, that I could not at this moment profess to answer exactly as to the number of drains which discharge into the river, and the number of closets which are actually hanging over them; but I think that the latter are very few indeed.

3506. Are there not some of the old-fashioned privies hanging over the river?—The number of them now must be very few.

3507. Supposing that there are privies of that kind, is there any mode of preventing their being connected with the river?—We have just now succeeded in putting this particular town of Oxford under the Local Government Act, and under that Act no doubt the powers of the Board will be much greater than they have been as to the pollution of the water by existing structures of that sort.

3508. Do you know whether the powers of the Local Government Acts would extend to the colleges?—I have no doubt that they would; the University has to send nearly a third of the Commissioners, and I have heard no doubt suggested as to that.

3509. You state that the overflow of the river is injurious to health; that is from the sewage that is diluted in water, is it not?—I do not think that that is the sole cause of injury to health.

3510. Does not the sewage increase the injury very much?—I am not able to state that. I believe that the great injury done to a district by an overflow of water is by the constantly sodden condition of the ground; the ditches are filled with a quantity of decomposed vegetable matter, which is not cleared out; the banks are constantly sodden, and there is no efficient drainage to keep any parts of the flat lands dry. I believe that to be the cause chiefly of the bad health of the district.

3511. Do you think that if the sewage were disposed of in any other way, the injury to health would still remain?—I feel no doubt about it; and the Committee will perhaps excuse my repeating (if it be a repetition) that the removal of the sewage from the river would not rectify the circumstances which are injurious to the health of the flat districts near the river. I believe that where the local circumstances cause an overflow of the river, this ill-regulated condition of the water producing the condition of the ground which I have described is a cause of ill-health, and therefore the removal of the sewage from the river would not remedy more than a part of the evil.

3512. Are there embankments on each side of the river at Oxford, or does the river overflow the whole of the lands?—It is a question of level entirely.

3513. There are cases where the rivers are embanked, and the farmers let in the water when they wish to have it; is that the case at Oxford?—No, that is not the case; and there is no power to compel anything of that kind, as is the case, fortunately, in Holland.

3514. Supposing that you took measures to prevent the flooding of those lands, would not the landowners and farmers look upon it as a serious injury to them, though, in fact, it is a benefit to the land?—Reverting to the word to which I drew the attention of the Committee, "regulation" of the Thames water, I would wish, in answer to that, to say that it has never been proposed by any of those who have agitated this question regarding the Thames basin, to let the waters off, so that it would be no use to those farmers and landowners; but we wish that they should

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should be retained in the condition which engineering skill shows would be the best for using them; so that the farmers would be able to use them for that purpose as required, and not as now in an intermitting way, without any reference to the wants of their lands. Therefore, we adopted most carefully in that memorial the word "regulation," because we found that it was constantly supposed that we wanted to get rid of those waters at all hazards; all that we want is, that they shall be under management; but that is an agricultural question, of course.

3515. Mr. *Caird.*] You speak in this memorial of the injurious pollution of the water; would not that injury very much depend upon the volume of water in the rivers to which these *excreta* flowed?—No doubt a concentrated poison is more mischievous than a diluted one; you get a larger dose in the same quantity.

3516. Is it not possible that the volume of water might be so great as entirely to do away with all injurious and noxious effects to health, with regard to such *excreta* going into the river?—Theoretically that may be so.

3517. You specially refer to this memorial to the basin of the Thames; have you yourself observed the condition of the river above Staines, or between Walton and Staines, which is below every one of the towns mentioned in this memorial, except Richmond?—I have seen it, but I have made no scientific observations upon the condition of the water.

3518. You have not examined it chemically, have you?—No.

3519. Have you examined it superficially, and looked at it, and seen the condition of it?—I could make no scientific report upon that; I have pulled down there on purpose to see it.

3520. Have you not found that it looked pretty pure to the eye?—It is three or four years since I was at that part of the river, and I could give no answer to that which would be of any scientific value.

3521. You have never observed that any system of deodorisation has been attempted to be applied to the privies that you have mentioned in Oxford?—We have had a few experiments made, merely as experiments; but nothing of that kind is at present applied to any extent.

3522. So that that mode of remedying the injury has not been attempted at all?—That mode of remedying the injury has not been attempted in Oxford; I need not say that in other towns it has.

3523. Has your attention been at all directed to that mode of remedying the injury?—Yes, generally.

3524. Do you think that it is a practicable remedy?—I know, as is well known to the Committee, as is stated in many reports, that there are ways of deodorising water to a certain extent, as appears especially from Professor Way's evidence.

3525. Are you aware of any mode of deodorisation which, in your opinion, has proved perfect for its object?—I have made no experiments upon that matter myself, and therefore I refer to Professor Voelcker, Dr. Frankland, Professor Way, Dr. Thomson, and others, who have paid very careful attention to these subjects, and who can give positive opinions upon it.

3526. Has your attention been directed to the effect upon water from factories, such as paper-mills or print works, or works of that description?—Not in our neighbourhood.

3527. Are they not found at all in the valley of the Thames?—Yes, we have paper-mills.

3528. Have you not had your attention directed to the injury caused by such works?—No.

3529. Are you not aware how that affects the streams with regard to pollution?—I am aware of the opinions of several chemists on the subject.

3530. Then does your evidence apply almost solely to the injury done by sewage in polluting the water of the Thames?—My evidence applies to the whole question of the condition of the valley, so far as it affects health. I think that anything by which either a river is polluted, or by which a river is allowed to overflow its banks, and cause a swampy condition of the land, is injurious, and it is my evidence that that ought to be remedied as far as possible.

3531. Have you any proof that injury has been done to health by the pollution of the River Thames above tide mark?—It is exceedingly difficult, as I stated at the outset, to get positive proof on matters of this kind. The only way in which positive proof (and even that can hardly be called positive) can be obtained on such points, is by examining the Registrar General's Reports, or having a special inquiry conducted by him. I am very anxious not to exaggerate or over-state any matter of this kind, and I have no doubt that, in order to answer that question precisely as to the effects of sewage, or as to the effects of damp in any district, it would be necessary to examine the death records with very great care, or we might be deluded by the complicated nature of the causes of ill health.

3532. Would it be possible for the Registrar General to separate such reports as to whether the deaths were caused by the damp nature of the ground, or by the pollution of the stream?—I should say that it is a most difficult thing to state exactly, from those statistics, the conclusion that ought to be drawn from the action of those particular causes; and, therefore, I wish to speak most carefully, because the variation of the soil merely, the variation of the habits of the inhabitants, and other causes of that kind, influence the circumstances exceedingly. I wrote a letter on that subject, which the Registrar General inserted in the Quarterly Report of his office in the year 1861.

3533. Is there anything in that letter which bears upon this point?—Yes, there is. It was in consequence of certain cases of fever which occurred, and on which inquiry was made, and I wrote to the Registrar General, suggesting what, in fact, has been the subject of inquiry by this Committee, that "the drainage of the whole Thames Valley above Teddington Lock ought to be in the hands of a Government Commission; there would then be some hope, first, that the towns on its banks would be induced to adopt the best known system for disposing of their sewage; second, that the Upper Thames waters would be made as pure as possible for the use of the metropolis; third, that the waters would be so regulated as to be quickly let off when accumulating, and retained at a proper level when falling; fourth, that the death-rates on the banks would be diminished.

3534. You do not make any statement there as to the fact of the death-rate being great or small in consequence of the pollution of the river?—As I have stated, I do not think that it would be possible to make a numerical statement to that effect correctly, except by a careful inquiry at the Registrar General's office; and I am not sure that they could do that with precision, except by strict local inquiry. As to the general fact that the neighbourhood of polluted streams is a cause of death, I have not the slightest doubt.

3535. Perhaps it might indicate it to some degree if you could give us the death-rate at the present time as compared with what it was 10 or 15 years ago, when the pollution was much less than it is now?—The death-rate was nearly 23 per 1,000 some years ago. I have not had the recent death-rate computed; but it would be observed that in many respects the dwellings of the inhabitants of Oxford are much improved, and, therefore, a fallacy would lie in that direction. The circumstances of the people are improved; the town is better drained; open sewers have been covered over; open ditches filled up; there is a better water supply, and so forth.

3536. Practically, so far as the health of the inhabitants of Oxford is concerned, it does not appear that it has greatly suffered from any pollution of the river; may that conclusion be drawn?—I cannot say that I know that it has so suffered; but I know that there is a much better water supply now, and, therefore, I have no doubt that a great number of persons have much purer water than they had at that time, and, therefore, simultaneously with any supposed deterioration of the river from the sewage, we should have an improved water supply, removing one of the causes of illness, while another cause, perhaps, had been added.

3537. Are you aware that it is the fact that the sub-drainage of the land in the valley of the Thames has very materially modified the condition of the soil there with regard to the state of the land?—I cannot say.

3538. Have you never heard it stated that the farmers complain now that the waters of the Thames are not so useful for irrigation as they used to be, and that they ascribe that to the fact that the drainage waters are so rapidly carried off by the drains and taken away to the sea, that the water itself of the river has become comparatively poor and does not contain so many of those elements which are so useful to the ground, and that that supply is carried off by the drainage on the surface instead of being carried through by filtration?—I have heard some statements of that kind; but whether they had any foundation or not, I do not know.

3539. You state, as I understand, that subdrainage and the removal of the sodden condition of the soil would, in your opinion, very materially improve the health of any district; is that so?—Of that I think there is no doubt, in a swampy district.

3540. Referring to the valley of the Thames, is it not necessary for the purposes of navigation, and is it not also necessary for the purposes of mill-power to retain a sodden condition of the soil on account of the locks and mill-dams?—That may be so; but I do not believe that the water-levels should be so maintained as to produce floods.

3541. If those locks and mill-dams were removed, would not the waters of the Thames go off much faster to the sea?—Unquestionably.

3542. And the banks would then be less sodden, would they not?—Yes.

3543. But you could not continue the navigation of the Thames or continue the mill-power if you removed all those dams and obstructions?—That would be the effect, no doubt.

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3544. Then it becomes a question as to which of those two things are, in the eyes of the inhabitants, the most valuable, the health of the district, or the navigation and the mill-power?—I feel the greatest delicacy in answering questions of that kind, or in being drawn into engineering or commercial questions, but still I must say that it has never been published by anybody of persons with whom I have been connected, or by anybody else, so far as I am aware, that it was intended to draw off all the water of the district; what is required is to keep them at a certain level; I believe that it would be most injurious to a district to run the water right off, and probably it would be injurious to the health of the inhabitants.

3545. It would be injurious with regard to the purposes of agriculture, it would be injurious with regard to navigation, it would be injurious with regard to mill-power, but would it not be beneficial to the health of the inhabitants that that sodden state of the soil should be removed?—Yes, but I think not in that way.

3546. In what other way could you remove that sodden state of the soil, which is caused by embanking, and by that constant state of stagnation from those waters?—By keeping them at a certain level.

3547. Are you aware that the soil of the valley of the Thames is of a most porous character?—In many places it is so.

3548. Is it not so in most places?—I cannot say.

3549. Sir *Joseph Paxton*] As I understand, you do not propose to get rid of those obstructions on the river; at what height do you suppose that it would be necessary to allow the water to stand, so as not to damage the mills and weirs, and other obstructions on the Thames?—I believe that there is no very great objection to what is now called, in most places, the high water mark, so long as we can keep the water at that; the mischief near Oxford arises in consequence of the outlets being too small at Sandford, and that the water rises up to a certain height, and then takes two or three days, or weeks, as the case may be, to flow off. The proposal which has been made by various engineers to us in the district of Oxford has been to make certain contrivances so that the water should not rise; that is the problem which we want to have worked out.

3550. But still, must not the water be dammed back inland for a very long way, to keep that high-water level?—Yes; but that level ought to be of course regulated by experiments, so as to fix the exact level, and the means of keeping the water at that level was one of the subjects of the inquiry which we petitioned Sir George Grey to set on foot both for sanitary and economical purposes.

3551. Has there been any investigation in the Thames Valley, in the neighbourhood of Oxford and that district, to enable you to know what would compensate the parties interested in those obstructions for taking them away?—No; we have had no power to make those inquiries, and the first object of that memorial, and, so far, of my evidence, is to elicit trustworthy facts upon all those points which we have had hitherto no means of getting.

3552. Did I rightly understand you to state that

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that you consider it as necessary to take away this sodden state of the land as it is to get rid of the sewage?—As a physician, I say that, for purposes of health, this is necessary, as I stated just now. It is not safe to make positive statements on points of that sort, but, taking it generally, I believe it to be necessary to have a dry atmosphere, and not to have humid exhalations extending over the ground; and I also believe that the sewage is injurious to health.

3553. Supposing that the sewage were pumped up to the level which you have described, and were thence sent down into the valley for the purpose of irrigating the land, so as to make use of the sewage, do you think that that would tend to damage the health of the valley?—There have been various opinions as to what is the effect of water meadows and irrigated meadows on the health of the district. I should be sorry, as a physician, to advise an extensive system of that kind close to a populous district; but I suppose that a moderate extent of irrigated land, at some distance from a town, could do no harm to the health of the inhabitants.

3554. Would there not be a very great difference between the effect of meadows irrigated with pure water, as is constantly done, and of those that are irrigated by sewage, which is of course very impure water, brought from the towns?—As is well known, and as has been repeatedly stated by chemists, and others, the power of the soil in purifying water, is most remarkable, and operates, not only very efficiently, but very rapidly.

3555. Does not that depend very much upon the nature of the soil, as to the water being able to percolate and get away?—Unquestionably it must be so.

3556. What is the nature of the surface soil around Oxford?—Our soil is chiefly clay or gravel, for some distance.

3557. But what is the surface soil?—Generally, in the low ground, there is alluvial deposit on gravel or clay.

3558. Would it be advisable, in a sanitary point of view, supposing that this sewage water were carried up to a great height, to put the irrigation of Oxford over the lands in the neighbourhood?—Not on soils of an impervious kind.

3559. Have you carried out any works already at Oxford?—We have not carried out any works at all there; we have had a great deal of difficulty; we have lately put ourselves under the Local Government Act, abolishing our old Acts, no large works there being possible under those Acts.

3560. You propose to have a Commission for the purpose of examining the subject, do you not?—We did: those eminent persons, who signed the Memorial, which I have handed in, proposed that there should be an inquiry; in what form that inquiry should be made is another question; but we proposed that there should be an inquiry into the condition of the Thames Basin as a whole, in order to ascertain exactly what effects do exist, and to ascertain the best mode of remedying the evil effects, if there be any.

3561. Do the parties who signed that Memorial suggest any mode by which the payments should be made, to the various parties who would require compensation?—No; they suggested an enquiry.

3562. Then, is it your intention to throw upon the Commissioner, or upon the Commission, the scheme, not only for seeing what is the right way to do it, but also to find out the means for doing it?—The suggestion to the Home Secretary was to make an enquiry into the subject.

3563. Would it not be right to carry out such an inquiry in other large valleys, as well as in the valley of the Thames, if such an enquiry took place?—It has been carried out to some extent. There was at the time, without the knowledge, perhaps, of most of the persons who signed that memorial, a commission sitting, and that commission reported, I believe, not long after that memorial was handed to Sir George Grey, with regard to other rivers. The reasons which actuated us in proposing this enquiry with regard to the Thames Basin, are set forth in the memorial.

3564. Has Oxford increased in population very much within the last 20 years?—Not very much.

3565. Is its sanitary condition about the same as ever?—I think that it has improved, but I have not had the death-rate calculated.

3566. Mr. *Adderley*.] Upon what ground do you suppose that the health of Oxford has improved; has anything been done to improve it?—The city has spread very much; many of the people are living in better houses; we have also a better water supply, and I think that in many respects the people are better off than they were.

3567. Has there been any improvement in the drainage or in the sewage works of the town?—We have made a considerable number of drains in the town, and those drains are now steadily increasing and will increase. Unless we take further steps we shall pollute the river so as to make it really unbearable. That operation is just beginning, as it is in all towns that are in course of improvement. Unless we have a system of main sewage to carry the sewage away from the town, it will shortly be worse than it is now.

3568. All the improvements take the line of breaking up the cesspools and discharging the sewage into the river, do they not?—Yes, at present they do.

3569. You have stated that works against pollution, and works against flooding, would be connected; how would the works for those two objects be connected?—I stated that the works for those two objects would be connected, because, for instance, we should get an outfall for the sewage, and I hope for the flood water at the same point, namely, at Sandford. I think it eminently desirable to arrange simultaneously for the proper discharge of surface waters, and of sewage.

3570. Do you propose that a great *cloaca maxima* should be conducted down to that point, three miles below Oxford, or in what way would the outfall be arranged?—Sir William Cubitt drew up a plan for us, and made proposals to that effect, so far as the sewage was concerned.

3571. Was that for conducting the sewage of Oxford to a deposit there?—To a deposit three miles below the town.

3572. Then there is a plan made for the purpose of draining Oxford?—Yes; but that plan is not adopted; it is only proposed.

3573. Do you suppose that the deposits of sewage have actually raised the bed of the river at Oxford?—In some places I believe that they have.

3574. Are there other towns in the basin of the Thames which joined with you in the memorial to the Home Secretary?—Inhabitants of several places joined in that memorial.

3575. Could

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3575. Could you mention the principal places in the basin of the Thames that you may say were represented in that memorial besides Oxford?—We did not attempt to get a great number of signatures to this memorial, and a few persons only were asked in the several places. I may mention the mayor of Banbury; Mr. Clutterbuck, who has paid a great deal of attention to this subject; the mayor of Wallingford, and the town clerk of the same place; Mr. Benyon, the Member for Berkshire; Mr. Acworth, of Plumstead; and the mayor of Henley; besides many eminent persons in London.

3576. Your proposal for a Government inquiry or a Royal Commission, of course, applied not only to the basin of the Thames, but to all the rivers of England; was that the case?—We thought that it would be a great advantage to have such an inquiry conducted with respect to that basin at all events, and we thought that it was our duty to press for that, thinking that it would serve as a model for all others.

3577. Are there not many basins, such as the Mersey, of which Manchester is the centre, which would require investigation, even more than the valley of the Thames?—I have no doubt that others would require it more.

3578. Do you think that in any plan, or any body formed for the conservancy of the Thames, the river both below London and above London could be under one conservancy?—Originally it had been the intention of several of the memorialists to draw up this memorial with regard only to the river above Teddington Lock, but they were pressed by persons in the metropolis to draw it up with regard to the whole of the Thames Basin, and that being a more complete view of the whole question, we above Teddington could have no objection to inquiring into the whole, as far as we were concerned; but we originally intended to apply it only to the part of the river above Teddington.

3579. Would it not be very possible to have two boards of conservancy, one to act as far as the tide reaches and one above the tide?—Certainly.

3580. Now that you have a local Act at Oxford you may be compelled to introduce a better system of sewage in your own town as there is a body to proceed against; is not that the case?—Yes.

3581. Before you had a Local Government Act, was there not another Act under which certain bodies could be proceeded against, and compelled to remove the nuisance of which you complained?—Yes, that was so.

3582. How was it that no steps were taken against them?—The individuals until lately were not prepared to proceed against them.

3583. Were you anxious to get the Local Government Act to facilitate those proceedings?—That was so, but further than that, we had no powers under the old Acts either to purchase land or to borrow money, so that under those old Acts it was impossible to proceed satisfactorily with any great work.

3584. What powers have you now?—Under the Local Government Act we shall be able to purchase land within the district, and to borrow money.

3585. Are what further powers you now want chiefly for the purpose of the outfall?—Chiefly for the outfall, or more properly for the regulation of the flood waters as a whole.

3586. There are outfall powers given in the Local Government Act, but those would not be sufficient for your purpose, is that so?—I could not answer that question.

3587. Have you yourself formed any opinion with regard to the nature of the Board of Conservancy under whom you would place the basin of the river, as to how far it can be a Local Board, or how far it must be under Government?—I think that it would be quite premature on my part to give any opinion upon that point.

3588. Do you know of any precedent for such a Board, either in old Acts in the country or in any proceedings of any other countries?—No.

3589. You stated that it would be necessary to keep a river from being either too high or too low; what sort of means would you take in order to keep a river from being too low?—It was suggested just now, the removal of such obstructions. As is well known, there are locks and pounds of various kinds up the whole of the Thames, by which the water is maintained up to a certain level, so long only as the water which comes down above those obstructions is sufficient to reach that level.

3590. Supposing that by any miracle you could get rid of all those mill-dams, locks, and weirs, would you not then consider that the river would get too low?—It would, at certain seasons, unquestionably, as the river now is.

3591. Do you mean that it would be too low for navigation or for health? — Probably for health as well as for navigation.

3592. Supposing that you got a river too low, have you any plan by which you could get it up again to what you would consider the necessary height?—The only way would be by further rainfall, I am afraid. There is a gentleman at Long Wittenham, the Rev. James Clutterbuck, who has taken great pains to inquire into several of those questions concerning the water supply of the Thames, who read a paper to the Society of Engineers upon the subject not long since.

3593. Will you explain to the Committee your views as to keeping the river too low, both as to the object and as to the means; supposing that all artificial obstructions were taken away, and that the river took its natural course, what would be the harm of that?—I expect that the bed of the river would be exposed during a great part of the summer, and the condition now, unless all the sewage deposits which had been going on were removed, would be, I take it, frightful; in fact, as it is now, when the river gets very low, we have the accumulation among the rushes of the feculent matter and impurities of all kinds.

3594. But, supposing that you had taken away both pollution and obstruction, what then would be the harm of letting the river take its natural course: would it not be sufficient for all natural purposes?—I would rather that the engineers should speak to that point.

3595. But did you not lay stress upon that?—I did lay stress upon that, because, from all the information we have as to the existing state of circumstances, I imagine that if the obstructions were taken away, the bed of the river would be, in some parts of the year, almost laid bare; but whether it might not be greatly improved without a great deal of labour and expense, I cannot say.

3596. Your idea appears to be, that by breaking down Sandford Dam, you might get complaints

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from below; what injury could you do below by removing pollution or obstruction above?—The river, a few miles below there, has another obstruction, and if we succeeded in throwing down the accumulated water, in a great rush upon them they would be more flooded, unless they had a proper construction of weirs accordingly.

3597. That would be only at the first release of the dammed-up water?—Yes.

3598. Would it not produce the same amount or collection of water below, whether there was a dam above or not?—Yes, but not with the same rapidity.

3599. You seem to object very much to cesspools; are you aware that they are rather getting back into use in Nottingham and the larger towns about Manchester?—I have heard that that is the case.

3600. Supposing that cesspools could be covered, so as to prevent an effluvium, and were also cleaned out regularly by a system of town scavenging, should you have the same objection to such a system of cesspools as against the old system of cesspools?—What I intended to state before, and what has been already stated in the essay which has been referred to, is to this effect: that the old cesspools, which were merely pits in the earth, were most injurious to the health of the inhabitants in the adjoining houses. I have no doubt, however, that there may be localities, separate habitations for instance, or small villages, to which an elaborate system of sewage really would be inapplicable from engineering reasons, or from reasons of expense, and that a proper and careful arrangement of cesspools, which should not overflow, which should easily be cleaned out, and from which the material might be transferred to neighbouring grounds, and so forth, might be tolerable; and I know that in some villages even experiments have been made to test that plan, but that is quite a different thing from the old cesspool system in towns.

3601. Is it your general opinion, without entering into the detail of the question, that sewage flow, except from cesspools, if conducted through a pipe, can be profitably utilised for manure?—I have stated before that the knowledge which I have on that point is chiefly, in fact I may say wholly, derived from the reports of persons who have specially investigated the subject, and that, therefore, I have no original information to give on that point; I must, indeed, also, guard myself by saying, that it is clear that the value of the sewage is dependent a good deal upon the ground upon which it is thrown.

3602. From your chemical knowledge, should you say that there is any mode of deodorising manure which does not destroy its value?—Some of those who have paid attention to the subject think that that is the case.

GEORGE HENRY WALKER, Esq., called in; and Examined.

G. H. Walker, Esq.

3603. *Chairman*.] YOU took a lease of the sewage of Rugby, did you not?—Yes, in 1853.

3604. For how long was that lease?—For 20 years, renewable at my option for 20 years more.

3605. What were your objects in taking that lease of the sewage?—One was to purify the river, or rather to preserve it from pollution; and another was to fertilize my own land in the neighbourhood.

3606. The one object you regarded as a necessary complement to the other?—Yes, I thought it would be more or less so.

3607. Did you erect any works of distribution on your land?—I constructed a tank, put up a steam engine of 12-horse-power, and then put down iron pipes.

3608. What quantity did the tank hold?—150,000 gallons; and I then put iron pipes under ground, to the extent of about six miles, in five main radiating branches, with subsidiary branches.

3609. Your land is in ridge and furrow, is it not?—In great part it is.

3610. And you conducted the sewage by underground pipes to the highest parts of the fields, and then carried it by open carriers along the top of each ridge, was that so?—That is the plan which I adopted more recently; first, I adopted the plan of distribution by a gutta percha hose.

3611. You exchanged that plan for another?—Yes.

3612. And now does the sewage flow from the gutters, along the top of the ridges, and over the sides of each ridge?—Exactly.

3613. From that time, have you constantly used the sewage from the town on your land?—Yes.

3614. And on about 100 acres of the land of a neighbour of yours?—Yes, he has used it on that land.

3615. You have watched the results very carefully, have you not?—Yes.

3616. Do you consider that the application of sewage is beneficial to all kinds of crops?—It may be questionable whether it is beneficial to white crops, it would depend upon the season and upon the land; but to all green crops, and especially to grasses, it is beneficial.

3617. Do you think that the distribution of the sewage of towns is likely to pay?—Yes, under all ordinary circumstances, and very much so under very favourable circumstances.

3618. When the town is high might it be distributed by gravitation?—Yes, and then you would increase the profit very considerably.

3619. When it has to be pumped, does not that reduce the profit by the expense of pumping?—Yes; just so.

3620. But you consider that that would be the best mode of distributing the sewage?—Certainly, the best mode that I have heard of when it is once reduced to a liquid form; but I have great doubts whether it is desirable to reduce it to a liquid form, even if the town has water supply.

3621. Have you found anything offensive or unhealthy in your use of the sewage?—I should say decidedly not on the whole; there have been some complaints, but they have died away, and I think the general opinion is that it is quite innocuous; but it depends upon how it is used. If it is allowed to fill hollows in the ground, and to stagnate, then it becomes offensive; but if used in a moderate quantity, it is quite inoffensive.

3622. What are the quantities that you would recommend as being moderate?—Speaking in thousands of gallons, which I generally calculate by, I should say from 100,000 to 200,000 gallons an acre a year, but that should be put on in five or six dressings.

3623. If the object is merely to get rid of the sewage, you might put it on in a greater quantity; but if the object is to make a profit, would it not be desirable to use a less quantity?—The land would take a much larger quantity.

3624. If your object is to make as much profit as you could out of the sewage, how many tons per acre would you apply?—About 500 to 1,000 tons an acre in the course of the year, in about five or six dressings.

3625. There were some experiments, were there not, which were carried on by the Sewage Commission under the direction of Mr. Lawes, and Dr. Gilbert on your fields?—Yes.

3626. What can you say concerning the results of those experiments?—I do not think that the results can be looked at as proving anything; the experiments, as regards agriculture, were conducted in such a way as not to show what sewage generally, or any given quantity of sewage would produce.

3627. Do you think that the results of those experiments are likely to mislead the public?—Yes, decidedly; the sewage has not been applied in the best way, agriculturally.

3628. For what reason do you say that?—Because there was a preconcerted system of watering certain plots at stated times, without reference to those times being just the suitable times for watering the ground; for instance, there were three plots in each field, and they were to be watered *seriatim*, at given times, without reference to whether the grass was just then ready for watering or not. The grass was allowed to grow extremely rank, till it was quite dead at the bottom; then it was cut, and the dry stubble, like stalks, left to dry a considerable time in the sun, and then, and not till then, it was watered again, and took a considerable time to revive.

3629. Then the ground seems to have been drowned at one time, and parched at another time?—In a great measure that was so.

3630. Was the effect of those experiments to kill off all the finer and better grass, and to leave only rank coarse grass?—That was the effect, to a great extent; so much so, that I am told that the land has been injured to the extent of 20 *l.* an acre.

3631. During that drowning of the plots, was there any waste of sewage?—A very great waste.

3632. Have you seen it running off the ground at those times?—Yes, constantly; it will do that more or less with any ordinary watering; but, then, it goes off clear if it goes off after having really drained through the land.

3633. Was there also a deficiency in the supply of sewage?—Yes; I understand that they could not get the supply at times that they wanted; so that the watering was the more irregular.

3634. Was not the piece which was destined to receive the smaller quantity of sewage at times parched?—Yes.

3635. Consequently, on all those three pieces was not the produce very much less than if the sewage had been applied economically and rationally?—Yes; I am satisfied that a much smaller quantity of sewage might have produced a very much larger produce.

3636. With a smaller amount of sewage, do you think that a better amount of return might have been obtained if wisely proceeded with?—Yes.

3637. Then, do you think that the report of the Commission, although it states the results which Mr. Lawes observed, is very delusive?—I think that proves nothing as regards the value of sewage, and that it tends to mislead.

3638. Should you say that for every thousand tons applied you only got one-eighth of the produce you might have got?—I could not say that; I could not say what specific difference there has been; but if you increase the quantity, and so put it on as not to give the greatest result, it has a double effect as regards the ratio of the produce to the quantity applied. If you put on more than is sufficient, but put it in a way that is not suitable for the ground, you have a double loss; you lose your produce, and you waste your manure; so that the ratio of produce to quantity of manure becomes doubly affected.

3639. Did you not state that your ground had been actually deteriorated in value by these applications of sewage?—Yes; I understand that a gentleman who is going to become the tenant has had it valued, and that it was estimated as being 20 *l.* an acre deteriorated in value. It certainly has entirely destroyed the fine herbage; it has left the ground covered with tufts of coarse grass.

3640. Mr. *Sclater-Booth.*] You stated that you thought that it was doubtful whether the application of sewage was beneficial to white crops; has your experience been most with regard to wheat crops, or with regard to grass crops?—In grass crops: I should say that this land was only two years in my own hands, and was then managed by an agent, and has since been in the hands of tenants.

3641. Why should you think that it would be doubtful, when applied to wheat crops?—Because when applied the benefit has been very slight, if anything; at the same time, if it were more judiciously applied, I by no means condemn it for wheat crops.

3642. Do you consider that the application of sewage to grass is more beneficial than the application of pure water would be to the same grass?—Infinitely; incomparably more valuable.

3643. Is one reason why there is a doubtful benefit in the case of wheat crops, that wheat crops do not require much moisture?—The sewage is too diluted; if the sewage were very strong indeed, it might be more beneficial to them, but it is too watery for them.

3644. In the concession that was made to you for 20 years, was there any rent?—A rent of 50 *l.* a-year.

3645. Is that a nominal sum?—It is the sum which the town were willing to take, and it was not a great consideration, but certainly it was 50 *l.* too much; the boot ought to have been on the other leg.

3646. Mr. *Hibbert.*] What number of acres are there in your occupation?—The land of my own that is irrigated is nearly 400 acres, and from 50 to 100 acres is my neighbour's.

3647. How much of this land do you take from the town of Rugby?—None of it belongs to the town.

3648. Do you pay 50 *l.* for the mere use of the sewage?—Yes.

3649. Did the town of Rugby go to the expense of a steam engine?—No, I did that at my own cost; the town made the main drain down to the river.

3650. How is the sewage got into this tank?—It runs in from the main drain.

3651. Does it never go into the river?—Not that

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that which is used. The overflow from the tank does.

3652. Have you made any calculation at all what it costs you per ton to deliver it upon your land?—I cannot say exactly, but I think that the works deliver nearly 200,000 gallons a-day. It costs, including the interest of money, nearly 500 *l.* a year, but the working expenses are not more than about 250 *l.*, speaking in round numbers.

3653. You state that you apply from 500 to 1,000 tons per acre; do you know what number of tons per acre were applied on the experimental grounds?—I think as many as 7,000 tons; I am speaking from memory, and from having read the report.

3654. How many crops of grass were obtained in a year?—Four or five; but I think my tenant of the other land only mows once.

3655. How often is the sewage applied to the grass-land?—I can give very little information as to the way in which it is now watered. I think it is watered three or four times, probably every summer; it is applied a great many more times to some lands than to others.

3656. Do you consider the farm more valuable since the application of the sewage than it was before?—It is considered so, certainly; the produce is much greater.

3657. Mr. *Caird.*] Do you farm yourself?—No; I did occupy the land for two years, but it was entirely managed by an agent, as I am not a farmer.

3658. You stated, did you not, that from 500 tons to 1,000 tons of sewage was, in your opinion, a sufficient application for an acre of ground?—I think it is a fair quantity to give, supposing that you had to turn the sewage to the best account.

3659. On what data do you found that opinion?—From my observation. I lived on the land and watched it for years.

3660. Your tenant cuts the grass only once, does he?—Only once, I believe.

3661. Is that from an application of from 500 to 1,000 tons per acre?—What quantity he puts on that grass that he mows once I cannot say now; but probably it would be thereabouts.

3662. By the application of 500 to 1,000 tons per acre, he obtains one cutting of grass in the season?—Supposing he puts on that quantity, and that he only mows once.

3663. And for four cuttings, would he require to apply four times that quantity?—That does not follow at all.

3664. Do you think that it would grow again without any further application of sewage?—Certainly.

3665. Would you have quite as good a crop without any further application of sewage?—No.

3666. Would you have any crop at all?—Yes; certainly.

3667. What does he do with the ground then?—He feeds cattle on it.

3668. Does he find that a more profitable plan than a system of mowing four or five times?—I presume he thinks so.

3669. He has not tried the other, has he?—I do not think that he has ever mown twice.

3670. Then he has not made a comparison between his mode of doing it and the mode in which it was done by the Commissioners?—No; I think not.

3671. You stated, did you not, that you give 50 *l.* a-year for the whole of the sewage, and that the whole quantity is 200,000 gallons a-day?—When the thing was in my hands, that was about the quantity pumped.

3672. Could you give us any figures, however small, that would represent how much per ton the town of Rugby gets for the sewage; have you ever calculated that?—No, I think not; but if you take it at so much per 1,000 tons, it would be a more reasonable calculation.

3673. Did you not state that you doubted whether the sewage should be applied in a liquid form at all?—My impression is that it is, under most circumstances, an unsatisfactory way of disposing of town refuse; but if, when once it is in a liquid form, you can make arrangements for putting it on land satisfactorily, and keeping it from any large dilution, it may be advantageous, but it injures the manure to be so largely diluted with water as to enable it to be distributed in this way.

3674. Is there any other mode, from your observation or inquiry, by which you think it might be distributed in a better way?—I should think that it is the best mode to keep it as night soil.

3675. You have stated that the water which was applied to this experimental produce, under the direction of the Royal Commission, was very unsatisfactory, and was not applied in the best way agriculturally—might not the failure of the grass have been caused by incorrect management of the system which was adopted?—I think that the deficiency of produce was owing to the defective arrangements for the application.

3676. Are you aware that if you manure highly any description of grass land, the effect must naturally be to cause the herbage to become coarse, but that it becomes very luxuriant?—That is true that it becomes luxuriant; but if it is cut when it is very young, the finer grasses will not be killed.

3677. Do you speak of that from your own knowledge and experience?—From my observation, and from what I have heard. I speak with great confidence on that point.

3678. The evidence which is before the Committee, with regard to the application of the sewage of Edinburgh, is of a contrary tendency, can you account for that?—I speak with great confidence on the point, from my own observation, and from all that I have heard and read; my opinion is that, however grass be manured, if the grass be cut young, the finer grass will not be killed.

3679. Might not the injury, to which you refer, be sustained by the system which had been adopted, not having been continued?—Certainly not; because it has been continued until the end of last summer.

3680. During the continuance of this system, did the herbage become very much injured?—Greatly so.

3681. Was it not to the last very luxuriant?—It was very luxuriant in the way that coarse grass is.

3682. If it had not been permitted to remain so long uncut, and if it had been cut in a certain systematic and proper way, do you imagine that then the herbage would have been injured?—It would not have been injured if it had been cut young, and if it had been watered immediately, the total produce would have been much greater.

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3683. From your answers it would appear that the injury was sustained not by an over application of the sewage, but by an improper application of the sewage, and by an improper treatment of the crop; was that the case?—The herbage was injured by the delay in cutting the grass, but the experiment was deteriorated in value by the waste of sewage, and by a greater quantity of sewage being pumped on to the land than could do any good. As the noble Chairman expressed it, it was drowned at some times, and parched at other times. A great deal too much sewage was sometimes put on, so that a great part of it would be wasted.

3684. Did you examine a great many of the experimental plots, and are you prepared to deny the accuracy of the returns made to Parliament by the Commission?—No; I believe that they are perfectly accurate, but that does not show that they are not misleading.

3685. Are you aware what was the number of tons of grass per acre from those experimental plots?—In round numbers the plot that was not watered produced about seven tons, and the piece that was watered least, produced about 14 tons. There was a regular gradation; the piece that was watered next most produced about 21 tons, and the next about 28 or 30 tons.

3686. Do you deny the accuracy of those weights?—No.

3687. Have you ever seen any tenants of your own, or any one who now uses the sewage in a small quantity, produce anything like so great a result as that?—No, because no ground has been laid for the whole year's grass-cutting, but I have seen much better results on other parts of the land.

3688. Do you mean that you have seen a crop of more than 28 tons per acre produced?—Yes; I have seen better crops than any of those that went to make up the 28 tons.

3689. Was that from any land in your own experience?—No, simply because we have not mown it for a whole year.

3690. Have you seen that amount of crops from any land?—I have seen much finer crops than that, and if it had been cut from time to time there would have been more than that.

3691. Are you aware that 28 tons a year is an enormous produce?—I am aware of that, but I have seen enormous crops.

3692. What would be the rent of this land which would produce 28 tons an acre?—It ought to be worth 5*l.* or 6*l.* an acre.

3693. What would you expect to get from 28 tons of green produce?—I cannot state that.

3694. Sir *Joseph Paxton.*] Did you go to the expense yourself of putting down those pipes?—I did.

3695. What pumping power have you?—12-horse power.

3696. How much did that give?—I calculate about 200,000 gallons a day in 10 hours.

3697. You first tried the application of the sewage with the hose, did you not?—Yes.

3698. Did you give that up?—Yes, it is cumbersome and troublesome, and the quantity distributed was comparatively small, and the flow was not sufficiently free to give the greatest quantity on the land.

3699. Besides that, would not the working expenses be much greater?—As compared with the quantity delivered on the land they would be greater, but otherwise not much greater. Each hose required a boy to attend to it; that is all.

3700. Then, is there not the wear and tear of the hose?—That is a comparatively small matter.

3701. And was there not a larger number of pipes?—There was only the hose additional.

3702. What is the nature of the land on which you applied this sewage?—It is on the lias formation; there is a clayey subsoil chiefly, but with a good loam on the surface.

3703. Was that the sort of land upon which the experiments were tried?—Yes, and it was extremely well drained to a depth of 4 feet shortly before.

3704. Is the other land well drained?—Not so well; but it is pretty well drained on the whole. The greater part of it has been lately re-drained.

3705. How do you use the sewage in the winter?—In just the same manner.

3706. Do you always continue putting it on?—Yes; in very hard frosts it is sometimes inconveniently obstructed, and it runs off, as it will not go into the land; but that is not often.

3707. You apply it on the ridge-and-furrow system, and let it run down and percolate on either side of the ridge, do you not?—Mostly so; some meadows have to be done partly with a hose.

3708. With regard to this grass which grows so coarse, do you attribute that coarse growth to the large quantity of sewage which has been applied, or partially to the nature of the ground?—No; it is remarkably fine pasture land. I believe that it was from the great quantity of sewage applied, and from the grass being allowed to grow too rank till it was dead at the bottom, and the finer part of the grass was killed; I have no doubt of it.

3709. Did you grow four or five crops?—Yes; four or five were grown by the Commissioners, but on my other land my tenant only cuts once to the best of my belief.

3710. Does he use the sewage directly it is mown?—I think that he does so as well as he can; but over a large quantity of meadows he cannot do so absolutely.

3711. How soon do you turn the cattle on to the pasture that is so irrigated?—Immediately; they would graze directly it was put on; they like it.

3712. Mr. *Adderley.*] Have you changed your opinion very materially during your experience of these Rugby experiments?—When I began I had of course very vague ideas on the subject; and one idea was, that a smaller quantity would do for dressing land; but, on the other hand, I did not know with what extreme facility it might be put on the land, and, therefore, one error counterbalances the other, and my opinion of its value remains about the same.

3713. Do you consider that the experiments with this Rugby sewage have been a failure?—I consider that they have been a failure so far as regards showing what sewage or a given quantity of sewage will do for land.

3714. But should you despair as to the advantage of that kind of application of sewage from any town?—Just the contrary; I am strongly in favour of the system, as I think that it is far the best; I think it is almost the only practicable system, and under ordinary circumstances a very profitable one.

3715. Then must not this 50*l.* a year be a cheap payment for the sewage, if it be profitably applied?—

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applied?—I do not think that it does much harm; but the expenses are great, and the trouble is great, and I think that the person who incurs those expenses and frees the town of the sewage should not be burdened with the payment of any sum whatever.

3716. Do you think that a man could afford to pay 50 *l.* a year for the Rugby sewage, if he had ground on which he could lay it out profitably?—I do not think that a tenant farmer would do so.

3717. Could you do so?—I can do so, because I can do it whether it is profitable or not, but I do not think that a tenant farmer, who had well observed its operation there, would do so under the same circumstances.

3718. Upon the plot of land which you are referring to, and upon which the sewage of Rugby is discharged, as it is now discharged, could a man profitably give 50 *l.* a year for that sewage?—He might make some profit, but I think that a more fair bargain would be that he should have it for nothing, because the expenses so balance the returns, and it is impossible to calculate to within 50 *l.*

3719. After 11 years' experience, can you say whether this system, on the whole, leads us to suppose that it can be profitably conducted?—Yes, I think it can.

3720. And more so than any other system, for the application of town sewage that has yet been tried?—The only other systems, so far as I know, are those of deodorizing and solidifying.

3721. The other systems are the deposit of the solid part and the use of the liquid portion of the sewage; comparing that with the net discharge of the sewage of a town through a pipe, which do you consider the best plan?—I think that the latter plan is by far the best.

3722. Sir *Frederick Smith.*] How long were those experiments being conducted, which you think deteriorated the value of the land 20 *l.* an acre?—I think either two or three years.

3723. Were they watched by you?—Yes.

3724. And the result was that you thought there was a loss of 20 *l.* per acre?—That is not my estimate; that is an estimate which I understand was put upon it by a land valuer who was called in by a gentleman proposing to become the tenant.

3725. What was the original value of that land?—£. 5 per acre rental.

3726. What description of soil was it?—It was exceedingly good land.

3727. Mr. *Adderley.*] Do you conceive that the report of the Commissioners of 1861 deceives by recommending a wrong application of sewage?—No; but their account of their experiments, as to the produce of the land by the application of given quantities of sewage.

3728. Can you state to the Committee whether the filter bed succeeds?—That is a complete failure; I think it does more harm than good.

3729. Why so?—Because it is always full of putrefying mud, and the sewage, by being passed through it, becomes more contaminated than it was before, and it goes into the river in a fouler state than if it had passed direct from the town.

3730. *Chairman.*] Would you object to state whether Mr. Lawes has stated to you, since the publication of these documents, his opinion that these experiments were not prudently conducted, and that therefore they would be delusive?—I was speaking to Mr. Lawes on the subject a few weeks ago, and he then admitted that the management of the land agriculturally had not been satisfactory, and that the results were not such as they otherwise might have been, speaking generally, and not certainly putting it in so strong a form as I myself have put it. He was speaking with respect to these very experiments.

3731. Mr. *Ferrand.*] Do you consider that the herbage has been injured by the application of the sewage?—Unquestionably, by that application; but I do not consider that the application, if properly conducted, is in the least injurious.

3732. Mr. *Caird.*] What is the population of Rugby?—Eight thousand.

3733. Do you make use of the whole of the sewage from that population?—I have the whole; but it is not all used: there is an overflow into the river.

3734. Are the Committee to understand that you consider you pay full price for it?—Under the circumstances, I think I pay 50 *l.* more than I ought to.

3735. Then if the term of your bargain were at an end, would you not be disposed to renew it?—I think not.

3736. Do you think that the sewage is not worth 50 *l.* per annum?—I think that, taking into consideration all the trouble and expense of applying it to the land, and some other objections, I should not be disposed to go on on those terms.

3737. You do not look to any great reduction of the local rates as likely to proceed from the utilization of the sewage?—I do not think that is probable, unless a different system is adopted. Where a town stands on a hill, and there is no pumping expense, and where the land is a light soil, and so forth, I think that a very large rental might be obtained. If the Rugby Board, instead of carrying the sewage in a drain, as they did, had put down an iron pipe, so that the sewage might have run over the land by gravitation, they might have had hundreds a year profit, as all the expense of pumping might have been saved.

3738. Mr. *Hibbert.*] You stated that the working expenses were 250 *l.*; if you add the 50 *l.* which you give to the Rugby Corporation, that makes 300 *l.* per annum, which, on the 300 acres of land, would be 1 *l.* per acre; do you consider that a large price to pay for manure?—No; I think that the money return will amply compensate for that expense, with proper management.

Mr. JOHN DALES, called in; and Examined.

Mr. J. Dales.

3739. *Chairman.*] You are an engineer and contractor, are you not?—I am.

3740. You have been engaged on extensive works in Canada?—Yes.

3741. Have you not also been employed by the Government in the construction of works?—Yes, I have.

3742. And you have been employed, I believe, by the Government to report on some proposed dockyards at Deptford?—I was engaged to make some borings, and to test the land for some new docks and warehouses down the Thames bank some time ago, and to report thereon.

3743. Are you not the proprietor and inventor of

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of a patent process for deodorising the sewage?—Yes, I did invent something of the kind some time ago.

3744. Drs. Hofmann and Frankland, it appears by this report of the Metropolitan Board of Works, No. 24, were ordered to report upon what they called numerous and ponderous documents, containing proposals for deodorisation; was not that the case?—Yes, they did so.

3745. Did they not report that yours was the only one that happened to satisfy the necessary conditions?—Yes.

3746. Your interest under that patent would be, that we should deodorise the sewage, would it not?—Yes. I do not think myself, from what I know of sewage, that it would require deodorisation if applied to land; it would only require it in certain cases, where you have stagnant pools, for example.

3747. You think that it is neither necessary nor desirable that the sewage should be deodorized if it is to be put on land?—I think so.

3748. Supposing you cannot put it on, as in time of frost; what would you recommend?—You can use it generally through the year, and I do not think that there would be much impediment from frost.

3749. Does not the earth possess a great power of abstracting fertilising matter from liquid?—It does; and it is a great deodoriser as well.

3750. Has this power of the earth to abstract these fertilising matters a limit?—Most decidedly.

3751. That limit is soon reached, is it not?—Yes; you may soon deluge it with the sewage.

3752. If you saw discoloured water running through the drains after you had applied the sewage, would you consider that that limit had been reached, and that the earth was already so saturated with fertilising matter that it could not abstract any more?—Of course.

3753. If you saw the water running from the land coloured, you would consider, would you not, that the sewage was wasted, unless the drains were too near the surface?—I should.

3754. Have you been at Alnwick?—I have.

3755. Are you aware that the Duke of Northumberland had erected works there for the utilisation of the sewage, and that after trying it three years, the farmers have refused to pay even the price of the pumping?—Yes.

3756. Can you explain why that experiment failed?—From my knowledge of Alnwick, I do not see how the sewage of the town could be worth anything, inasmuch as there are very few waterclosets that run into it; there are principally cottages, tanks, and cesspools away from the houses, all of which are emptied, and the sewage carried away by nightmen; and the sewage of the town would be composed of the mere washings and surface water; that is my opinion.

3757. Were you consulted with regard to the sewage of Croydon by the Local Board?—Yes; they had two or three injunctions against them, and they sent for me; and I was examined before the Master of the Rolls.

3758. Did they use your deodorizing process?—Yes, for some months.

3759. Did not they continue to use it for a long time?—They did use it for a long time, till they applied the sewage to the land; some gentlemen made use of the sewage.

3760. Did they then find that it was not necessary?—Yes.

3761. So that they did not use it any longer?—They have used, I believe, a small quantity of carbolic acid, which acts as a deodoriser; but it made the stream black, and very bad for fish.

3762. When they apply the sewage to the land, they do not use that, do they?—No; it is not necessary; the drainage of Croydon is very shallow, and it is a very difficult sewage to deal with; it is very different from the London sewage. The whole of the sewage of Croydon is conveyed into two or three large tanks, and the solid voidings arrive in those tanks in their unbroken state, and you have a complete lake of excreta two feet thick, or something of that sort. All the sewage flowing from our metropolitan drains is thoroughly broken up, and you have one valuable mass; but in that case you have not. The Croydon people have some works where they make a solid manure. I believe they collect the excreta from the tops of the tanks, and mix it with ashes, and use the rest as liquid manure.

3763. Have you applied the sewage on your own land?—About 15 years ago I bought an estate, and used it there.

3764. Did you apply it chiefly to corn?—Chiefly to corn; wholly to wheat.

3765. Did you grow corn year after year on the same land?—I did.

3766. And did you find it unnecessary to apply any farmyard manure to that corn?—During those seven years I never applied anything but sewage; it was more an accident than anything else. I kept 11 horses, and required a great deal of straw, but I could not purchase it in the neighbourhood; and having a number of brick fields and cottages, I had all the drainage and sewage from the cottages conveyed to a tank, and I had the excreta from those cottages mixed up, and that is what I applied. But I had wheat crops upon which no manure, but sewage was used.

3767. You used all the straw for stable manure, and sold it, did you not?—Yes; the straw grown on the land manured with the sewage was rather sweet, and the horses would eat it before they would eat clover, and that class of fodder.

3768. Did they like it better than clover?—They did.

3769. Do you believe that farmers would pay for the sewage, if it were brought within reach of their fields?—I have no doubt that if they could get at it, and that it was used in a moderate quantity, they would.

3770. Mr. *Sclater-Booth.*] Did those crops of wheat continue to improve year after year, or did they deteriorate?—The first crop scarcely paid me at all. I think I only got 3½ quarters per acre from it; but the seventh year I had six quarters and one sack.

3771. Is the improvement continual and progressive?—The improvement is continual and progressive. And, moreover, the millers were also rampant for my corn, because it was a very full grain, and full of flour.

3772. What happened after those seven years that you have spoken of?—I was going to build a house upon that field, and I laid it down.

3773. Mr. *Caird.*] How many acres did that field consist of?—Ten acres.

3774. You state that it has been under wheat every year for seven years?—Yes.

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3775. With the sewage of how many people did you manure this ground?—With the sewage from thirteen houses, and the men from the brick-field also went occasionally to the same place.

3776. Did you find that the sewage from thirteen cottages was sufficient for the regular manuring of ten acres of ground every year, producing a large quantity of wheat?—I had to dilute it with great quantities of water.

3777. In what way did you apply it?—By means of a watering-cart, and with an old man to attend to it.

3778. How often did you take the watering-cart over the ground?—I used to apply about 100 tons an acre, altogether.

3779. And you carted it all over the ground?—Yes.

3780. How many horses did you employ to carry the sewage over the ground?—Not more than two horses.

3781. During how many months in the year did you continue to apply it?—Not more than two or three months.

3782. Did you dress the whole of the ground?—I dressed the whole of the ground with sewage.

3783. Did they go over the ground frequently?—Yes; they used to go over the ground when it was tolerably dry, or in a frost; but I found that the difficulty in that case was from the wheels cutting the ground up.

3784. In what month was it that you applied the sewage?—I did it at various times. I used to sow the wheat in November, and I used to get the sewage on in the winter, I think in December and January; I have even put it on when the ground was covered with snow.

3785. Did the wheat crop continue increasing?—It did.

3786. From the first to the last were you getting always better crops?—Yes, I was. When I bought the land it was almost exhausted; I paid eighty guineas an acre for the land, and it lets now for six or seven guineas an acre. I laid it down for building, but I did not build upon it.

3787. And was that the reason why you gave up those profitable crops of wheat?—Yes.

3788. Does anybody use that sewage now?—No.

3789. Is so profitable a system as that entirely given up?—It is in different hands. I have sold the land.

3790. What becomes of the sewage of the cottages now?—The labourers use it on their gardens; they used to steal it from me, when they could get it.

3791. They must have it in great abundance, have they not?—No, I think not; the usual quantity from such houses.

3792. Mr. *Ferrand.*] There is no doubt that you have tried the effect of the sewage on those 10 acres of wheat, and you have seen the effect of it on those labourers' gardens; from your experience, has it had a beneficial effect there?—Yes; it grows good potatoes and peas, and that class of vegetables.

3793. Is there an increased crop from the application of it?—Yes.

3794. You have stated that the strength of the sewage was drawn from it very much according to the kind of soil to which it was applied; is that so?—Yes.

3795. Could that sewage be applied to any soil without leaving a large portion of its strength upon the soil?—All soils have a capability of abstracting fertilising matter, and will take up the chief strength of that class of manure; but a sandy soil, least of all. Good soils are very retentive of liquid manures, and only part with the fertilizing properties as the grain requires them.

3796. After it has passed through a soil, what has escaped into a river or into any stream would not have a very injurious effect, would it?—I should not think so, if put on in moderation.

Jovis, 16° *die Junii*, 1864.

MEMBERS PRESENT:

Mr. Adderley.	Mr. Hibbert.
Mr. Sclater-Booth.	Mr. Leader.
Dr. Brady.	Lord Robert Montagu.
Mr. Bright.	Mr. North.
Mr. Caird.	Sir Joseph Paxton.
Mr. Cowper.	Sir William Russell.
Mr. Ferrand.	Mr. Tite.

LORD ROBERT MONTAGU, IN THE CHAIR.

TOM TAYLOR, Esq., M.A., called in; and Examined.

T. Taylor, Esq. M.A.

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3797. *Chairman.*] YOU are the Secretary to the Local Government Board, are you not?—Yes.

3798. What powers are acquired by the Local Boards of the towns which adopt that Act, generally?—Perhaps the shortest way would be for me to read a short extract from a circular which we send round to the towns:—"Local Boards will have all the powers of Local Boards of Health under the Public Health Act of 1848, as modified and altered by the Local Government Act, with the additional powers of the Local Government Act. These powers, together, include those relating to sewerage, drainage, lighting, and water supply, scavenging, and cleansing; for the regulation of new streets and buildings, the repair of streets and roads, the laying out of new streets, and widening and improving old ones. Powers given by the Towns Police Clauses Act, with respect to obstructions and nuisances in streets; to fires; to places of public resort, hackney carriages, and bathing; powers given by the Towns Improvement Clauses Act with respect to naming streets and numbering houses, improving the line of streets, and removing obstructions; to dangerous and ruinous buildings; to precautions during the construction and repair of sewers, streets, and houses; to the supply of water; to the prevention of smoke, subject to qualifications in the case of certain enumerated processes; to slaughter-houses and docks. Powers for the provision and management of public pleasure grounds. If the Baths and Washhouses Act be adopted, or if the Burials Acts be in force for part of a district, the Local Board may, with consent of the vestry, be the Commissioners for the Baths and Washhouses or the Burial Board respectively. With consent of owners and ratepayers, the Local Board may provide new markets. The adoption of this Act supersedes the Watching and Lighting Act."

3799. How can towns deal with sewage under that Act other than by putting it into the rivers?—They acquired powers by the Public Health Act of 1848, in general terms, to cause the sewage and refuse from their sewers to be collected for sale for any purpose whatsoever, but so as not to create a nuisance.

3800. Is that continued under the Local Government Act?—It is extended.

3801. What is the extended power?—I may mention that the 46th section of the Public Health Act of 1848 enacted, "That the Local Board of Health shall cause the sewers vested in them by this Act to be constructed, covered, and kept so as not to be a nuisance or injurious to health, and to be properly cleared, cleansed, and emptied; and for the purpose of clearing, cleansing, and emptying the same, they may construct and place either above or underground such reservoirs, sluices, engines, and other works as may be necessary, and may cause all or any of such sewers to communicate with and be emptied into such places as may be fit and necessary;" and then the last clause was: "Or to cause the sewage and refuse therefrom" (that is from the sewers vested in them) "to be collected for sale for any purpose whatsoever, but so as not to create a nuisance." That was the original power.

3802. Might they place those engines and those reservoirs which were mentioned only within the precincts of the towns?—Or the precincts of the district.

3803. How was the power extended under the Local Government Act?—Under the 30th section of the Local Government Act, Local Boards were empowered to exercise the power given by the 46th section of the Public Health Act with regard to sewage also without their district, if necessary, for the purpose of outfall and distribution of sewage, upon making due compensation, to be settled in the manner provided in the 144th section of the Public Health Act of 1848, which is the general section for compensation.

3804. Under this Local Government Act, can they make reservoirs or tanks beyond the boundary of their district?—They could by this section which I have just read. It says, that they may exercise all the powers given by the 46th section of that Act, one of which is the construction of such works as may be necessary.

3805. Have they power to compel the sale of lands to them?—Yes; under the 75th section. The 30th section goes on to say that they may contract with any company or person for the sale of sewage, or for the distribution of it over any land; that is to say, they may either contract to sell it or to distribute it, or they may "contract for, purchase, or take on lease any lands, buildings, engines, materials, or apparatus for

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for the purpose of receiving, storing, disinfecting, or distributing sewage; provided always, that these things shall be done so as not to create a nuisance."

3806. Would you be good enough to state whether Local Boards meet with any difficulties in applying their sewage otherwise than by pouring it into a river?—Perhaps the Noble Lord will allow me to say that the power given by the 30th section has been still further enlarged by a subsequent Act, in consequence of the difficulties that had been experienced.

3807. What were those difficulties?—The difficulty that was found in practice under this 30th clause of the Act of 1858, which I have just read, was, that it empowered Local Boards merely to exercise the powers of the 46th section of the Act of 1848, for the construction of reservoirs, sluices, engines, and other works, as may be necessary, and the causing of all or any of such sewers to communicate with and be emptied into such places as may be fit and necessary; that power they might exercise beyond their district, but the Court of Chancery held, in a case of which I have a report of the judgment, that that Act did not empower Local Boards to construct a sewer beyond their district, and therefore it was necessary to empower them to exercise the powers of the 45th section, also, out of their district. The 45th section is the one which in terms empowers Local Boards to construct and repair sewers, "And be it enacted, that the Local Board of Health shall from time to time repair the sewers vested in them by this Act, and shall cause to be made such sewers as may be necessary for effectually draining their district for the purposes of this Act."

3808. Was that beyond the precincts of their district?—By an amendment of the Local Government Act in 1861, they acquired the power of the 45th section, that is, the power of constructing or repairing sewers beyond their district. The Local Government Amendment Act of 1861, which is the 24th & 25th Victoria, chapter 61, provides by the 4th section that "Local Boards may exercise the powers given by the 45th section of 'The Public Health Act, 1848;' also without their district, for the purpose of outfall or distribution of sewage, upon making due compensation, to be settled in the manner provided in the 144th section of 'The Public Health Act, 1848;' provided always, that nothing herein contained shall give or be construed to give power to any Local Board to construct or use any outfall, drain, or sewer, for the purpose of conveying sewage or filthy water into any natural watercourse or stream, until such sewage or filthy, or refuse water be freed from all excrementitious, or other foul or noxious matter, such as would affect or deteriorate the purity and quality of the water in such stream or watercourse;" those words were added after the Bill was introduced.

3809. Then, if I understand you rightly, they may make sewers and reservoirs and erect engines even without their district for the distribution of sewage?—They may, subject to certain conditions which this Act goes on to prescribe.

3810. What are those conditions?—That no sewer or other work shall be constructed or extended, under the enactment lastly hereinbefore contained, unless three months at the least before the commencement of such work notice of the intended work, describing the nature thereof, and stating the intended termini thereof and the names of the parishes, townships, and places, and the turnpike roads and streets, or places laid out or intended for streets, and other lands, if any, through, across, or under which the work is to be made, and naming a place where a plan of the intended work is open for inspection at all reasonable hours, shall be given by advertisement in one or more of the newspapers usually circulated in the place where the work is to be made, and a written or printed copy of such notice shall be served in manner directed by 'The Public Health Act (1848)' on the owners, or reputed owners, lessees, or reputed lessees, and occupiers of the said lands, and on the overseers of such parishes, townships, or places and the trustees, surveyors of highways, or others, having the care of such roads or streets. In case any of such owners, lessees, or occupiers, or such overseers, trustees, surveyors, or others as aforesaid, or any other owner, lessee or occupier who would be affected by the proposed work, object to such work, and serve notice in writing of such objection, on the Local Board at any time, within the said three months, the proposed work shall not be made or commenced without the sanction of one of Her Majesty's Principal Secretaries of State, after such inquiry and report as hereinafter mentioned. It shall be lawful for the Secretary of State, upon application of any Local Board, to appoint an inspector to make inquiry on the spot into the propriety of any such work as aforesaid, and into the objections thereto; and to hold one or more meeting or meetings for the purpose of hearing all persons desirous of being heard before him on the subject of such inquiry, and to report to such Secretary of State upon the matters with respect to which such inquiry was directed."

3811. You stated just now, did you not, that the sewage might not be allowed to flow into the river until it was perfectly freed and rendered pure from all excrementitious and noxious matter?—That is the proviso attached to this 4th section.

3812. Are you aware that in the examination with regard to the Uxbridge case, before Vice-Chancellor Wood, Professor Way stated that there were no means furnished by science by which water which had been once polluted by sewage, could be rendered perfectly pure and free from excrementitious or noxious matters, and that the Vice-Chancellor rested upon that evidence in the decision which he gave in that case?—I conclude so much from the report which I have seen of the case.

3813. Will you describe the usual practice of the Local Boards in attempting to deal with the sewage of their district?—The first course in almost every case, or I may say in every case, has been to look at the nearest body of running water, either a stream or the sea, where they are near the sea, and the first idea has been always to carry their sewage into that, so as to get it right off in that way.

3814. When they do so, is it not the case that they are liable to suffer, and often do suffer under injunctions from the Court of Chancery?—They do, and of late years the number of injunctions has been increasing. For some time after the Act of 1848 was introduced, the progress of those large combined sewerage operations was slow; it was something new for a town to carry out complete systems of sewerage works, carrying all the sewage to one point, and people were not awake to the consequences of that, but since these sewerage works have been carried on the streams have become very seriously polluted, and interference with Local Boards, by proceedings, either legal or equitable, has become much more frequent.

3815. Has one consequence of that been that it is much easier to obtain an injunction?—I apprehend that there was never any difficulty in obtaining in injunction.

3816. In Croydon they have had six or seven injunctions, have they not?—Yes.

3817. Can you give the Committee any information about that case?—I have not the particulars before me, but I know that the result was to embarrass the Local Board in dealing with the sewage, so that they had to give up the practice of sending it into the river. They first attempted to free it from noxious matters, but they found that insufficient, and they have lately leased land for the purpose of taking the sewage on to the land, and letting the land and deriving a profit therefrom.

3818. They first allowed the sewage to flow into the water, and they then suffered under six or seven new injunctions, with the expenses consequent on those injunctions; was not that the case?—Yes.

3819. Then they tried to free the sewage from noxious matters, did they not?—Yes.

3820. Did they then find that the only course was to turn it on to the land?—Yes.

3821. Then the injunctions in that case were effective, were they not?—They seem to have been.

3822. What was the Uxbridge case?—That was an injunction moved for by Colonel Tower against the Local Board, and the result there was that an injunction was made restraining the Board from discharging the sewage into the River Colne until it was freed from noxious qualities.

3823. Did they attempt to free it from noxious qualities?—The Board made an attempt, and it was considered by Colonel Tower's agent, and by Colonel Tower himself, that the attempt was unsuccessful, and they then moved the court again on the ground of a breach of the injunction; the case was heard, and the Board were ordered to cease for a certain period from allowing the water to run into the Colne without first obtaining the leave of the court; the effect of that would be, I suppose, that they were compelled to adopt some process which was considered satisfactory to Colonel Tower.

3824. The date of that was June 24th 1857, was it not?—Yes.

3825. And the order of Vice-Chancellor Wood was, that after the 28th of July they were not to allow the sewage water to run into the river?—They were not to allow the sewage water to run into the river without obtaining leave.

3826. Has anything further been heard of that?—I have heard nothing further, and therefore I presume that the matter has been arranged between Colonel Tower and the Board, either that they have improved their process or that they have given such terms as are satisfactory to him.

3827. Did they not propose, while their case was pending, to deodorise their sewage water with lime?—Yes.

3828. It was proved that that would be utterly destructive to the fish, was it not?—Yes, that was one point.

3829. Was there not an injunction obtained at Hitchin?—Yes.

3830. What was the result of that?—The result of that case was to suspend the operations of the Local Board at Hitchin. The Board were so afraid to go on with their functions, in consequence of their liability to proceedings, that they resigned *en masse.* No other members came forward for re-election, and Hitchin has been without a Local Board ever since. A receiver has been appointed under statutory power to obtain, in the shape of rates, the interest on the loan which had been raised at Hitchin for the sewage of the town, but there is no body at Hitchin exercising the functions of a Local Board.

3831. What becomes of the sewage now?—I presume that so far as the works are completed it runs into the river, but inasmuch as there is no body against whom the persons aggrieved can take proceedings, proceedings have not been taken.

3832. In fact, the only change is that the river has not been freed from the sewage, but that the town has been freed from the Local Board?—Yes.

3833. Do you not consider that some stringent measures would be necessary to prevent the pollution of streams?—Clearly something is required; stringent and extensive powers would be necessary.

3834. Under the Gas Works Act of 1858, are there not exceedingly stringent powers to prevent gas refuse from flowing into streams?—Yes; and there are heavy penalties imposed by the Local Government Act of 1858 for any pollution of streams under the control of the Local Board, by gas washings, and so on; but there is also provision under the Nuisance Act, which extends that liability to penalty.

3835. What is that liability?—The liability to a 200*l.* fine, and a penalty of 20*l.* a day.

3836. What you have been stating with regard to the Local Government Act, applies only to single towns, does it not?—The Local Government Act applies to single towns and districts.

3837. It does not apply at present to a whole watershed or catchment-basin?—No; the only power that would give anything approximating to such breadth of jurisdiction, is a power by which adjacent Local Boards may unite for common operations, subject to the sanction of the Secretary of State.

3838. But, supposing that they do not unite, might not the towns higher up on the stream pollute the water which the inhabitants of the towns below have to drink?—They might.

3839. There would be no unity of action, in fact, throughout the watershed or catchment-basin, under the present powers?—None.

3840. Then in fact by this Local Government Act that evil is not secured against, is it?—No, it has been increased.

3841. Was there not a case which occurred at Salford where it was proposed to expend 80,000*l.* for the purpose of freeing their river from their own sewage, on condition of Manchester and other towns joining with them?—I have heard of the case, but have no cognizance of it officially, Salford not being under our Act.

3842. Did you hear that the design had been abandoned, because the other towns would not join in the proposal?—I have been so informed.

3843. If the application of sewage to land were regarded

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regarded merely as a commercial speculation, might not a town refuse to commence expensive works on the score that it would not pay them?—I should think that that would be a very likely objection.

3844. They might have doubts as to the value of the sewage, and might refuse to carry out the works?—What they want at present is to get rid of their sewage; they do not think of turning it to profit.

3845. But if the law stepped in, and if there were sufficient authority to enforce the law against turning the sewage into the rivers, they would have to erect works, would they not; there is no other alternative?—I do not see any other alternative; and although under the Public Health Act first, and the Local Government Act afterwards, this evil is increased, I apprehend, from the regulations of the General Board of Health, who worked the Act of 1848, that they had always in view that alternative of the application of sewage to land as a means of preventing the pollution of rivers; they very early turned their attention to that point, and from the first moment of their institution in 1848 they directed the collection of evidence bearing upon the application of sewage matter to land; and they published in 1852 the result of their inquiries, pointing out to the Local Boards that there was an alternative besides polluting the streams, namely, that of applying the sewage to land, and showing, by such evidence as was then accessible to them, that such operations might be carried on profitably, as they believed.

3846. Evidence has been given before the Committee by Mr. Gael, a barrister of Lincoln's Inn, in which he stated that when the Commissioners of Sewers under the Public Health Act winked at a breach of the law in allowing the water-closets and house-drains to run into the sewers, that was done with the avowed intention that at some time the rivers should be freed from the sewage again, and that it should be applied to the land; do you concur with him in that opinion?—So far as I know the opinions of the Commissioners of Sewers at that time, through one prominent member of that body, who was himself a member of the General Board of Health, and, in fact, a leading member of the Board in point of activity, namely, Mr. Chadwick, that was the case; he certainly had that notion.

3847. Is it not within the last 30 years that the house-drains and the night-soil have been flushed into the sewers?—I suppose that it began, to a great extent, soon after the year 1840; almost every system of combined drainage in towns which is now in operation has been carried out since 1840, and the greater part have been carried out since 1852 or 1853.

3848. Are those the two alternatives, namely, either to allow the sewage to flow into the river, which is really illegal, or else to utilize it on the land?—I see no other alternative while you retain the system of sewers; there would be, of course, some possible system of application of the sewage in a dry form, supposing that the sewers were abandoned and cesspools were reverted to.

3849. Cesspools were at one time in general use, were they not?—Yes.

3850. Were they abandoned because they were found so destructive of health?—They have been protested against by all those who have had official dealings with the matter since 1848.

3851. And has not a vast amount of money been expended to get rid of these cesspools?—The general course taken has been to get rid of all solid excrement by sewers.

3852. If it be illegal to allow the sewage to flow into the rivers, why does not the law prevent it, and why are the rivers now in a very foul state?—The only explanation of that which I am provided with, would be that until the Public Health Acts were passed, the systems of combined works of sewerage were hardly known, and people were probably not aware in many cases of their power to prevent that pollution; they were not aware how far the fact that sewage had found its way by a number of water-courses into the streams, might bar their powers of taking action when the combined system was carried out; they were not awake to the evil, because so few towns drained into streams that the pollution of the streams was an evil of comparatively trifling amount. But since this system of combined sewerage has been gradually extending, there being now about 500 towns under the Local Government Act, many of which are carrying out sewerage operations, and all of which are more or less on the way towards it, the evil is becoming a very great one, and as those Local Boards gradually cover the country, they are of course in communication with each other, and cases are reported, and people who hear of the effect of one application to law or equity think that they may avail themselves of the same remedy, and so actions or proceedings for injunctions multiply.

3853. Is there any authority whose duty it is to enforce the law for the prevention of streams being polluted?—There is no authority specifically appointed for that purpose; there is an indirect means of doing it through the provision that when Local Boards carry out works of sewerage, they must apply to the Secretary of State, for his sanction of the loan for that purpose. He has the power to refuse his sanction; and he may refuse his sanction unless works are provided to remedy the evil as to the pollution of streams.

3854. But is not that a very indirect means, if it is a means at all, of enforcing the law?—Yes.

3855. There is no person, is there, whose duty it is to see that the law is enforced?—No.

3856. In fact, is it not left to private parties to obtain an injunction and to incur the expense of doing so, if they like to do so?—Quite so.

3857. Do you think that in such a matter as this, it is well to leave it in private hands?—If this evil is spreading all over the country, as I believe it is, and is likely to spread still further, and if, moreover, a great amount of fertilizing matter is wasted, as chemists and many agriculturists appear to think, it would be a matter of importance that some authority should be appointed to prevent the pollution of those streams upon a general system.

3858. Does it appear to you that in the case of a town allowing its sewage to flow into a river, it does not so much injure the town itself as it injures towns lower down the stream?—Clearly so.

3859. While if that town went to a great expense for works for the application of the sewage to land, it would have to pay for those works out of its own rates?—Yes.

3860. Is it not the interest of Local Boards to allow their own sewage to flow into the streams, and not to put it on to the land?—That may be so, except so far as they might derive some profit in aid of their rates.

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3861. Do you mean supposing that it is a good commercial speculation?—Yes; otherwise no.

3862. If there is any doubt on that point, is it not their interest to turn it into the river and not to apply it on the land?—Yes.

3863. Some of the witnesses who have been examined before the Committee have proposed a remedy for that state of things, namely, that the Local Government Act should apply not to individual towns but to a whole watershed or catchment basin; do you think that that would tend to remedy this state of affairs?—I do not think that the Local Government Act is framed for that purpose, and I should doubt extremely if it would be found applicable for such a purpose.

3864. Supposing that it were compulsory to appoint a Board which should have authority over the whole catchment basin or watershed, what would be your opinion upon that point?—An Act of Parliament would have to be framed defining the functions of such Boards, and giving them powers to execute their functions. They must have different functions and different powers also from those of Local Boards, and it is clear that you must have some authority which would control the whole district which is drained by any great arterial stream, that is to say, any one catchment basin or watershed.

3865. Would not the main duty of that Board be to keep the river free from pollution?—I should apprehend that that would be their principal duty.

3866. And it would be the duty of some authority such as the Home Office or the Board of Health, to see that that Local Board enforced the law with regard to the pollution of that stream, would it not?—When you come to the question of a hierarchy, each degree seeing that the one below does its duty, it is difficult to see where you are to stop. We know that in this country persons are very averse to investing the central authority with powers to control local authorities.

3867. Do you think that if the Board were a local authority, and if it were its duty to observe and enforce the law, there would be any control exercised by a central authority, if the Home Office were merely to see that the law was administered practically?—I think it comes to be control.

3868. Is it not the case with any other body; the Government really administers the law?—The law courts really see that the law is carried out, and not the Executive Government.

3869. Is not the law put in motion by the Executive Government?—Not necessarily so; it is generally put in motion by the application of the individual injured, or by the application of corporate bodies.

3870. But should you think that, in this case, it would be insufficient to leave it in the hands of an individual?—I am not aware that I have expressed that opinion.

3871. Have you not stated that it is not the duty of anyone to see that the law is enforced, and that a matter of this great moment should not be left in the hands of one individual, but that there should be some functionary to see that the law is observed; is that your opinion?—I can hardly answer the question by saying yes or no.

3872. Do you consider that some such Board ought to be appointed whose duty it should be to see that the rivers are freed from pollution?—If you intend to remedy this evil you must have a body with a very wide area of jurisdiction, but the point as to who is to control that body is of course a further consideration.

3873. Would it not be their duty to see that the law is observed?—They would have to see that the law is observed in that respect, that is to say, that the rivers are not polluted.

3874. Supposing that that body do not execute their duties, who is to put the law in motion?—I apprehend that where a positive duty is imposed upon a public body, as the common law at present stands, on any neglect of their duty, any person injured by their neglect can apply to the Court of Queen's Bench, which issues a writ of mandamus requiring them to do their duty. You have nothing corresponding to a public prosecutor in this country; in Scotland they have the Procurator Fiscal, who is charged with the duties of public prosecutor.

3875. Do you think that that would be advisable in England?—I do not give any opinion upon that point; I merely say that we have no such officer.

3876. Supposing that all local objects, such as streets, pleasure-grounds, and the like, were still left to the Local Boards, would not the same powers as are given under the Local Government Act be required for the Board of the catchment-basin or watershed?—I should rather apprehend that the functions of the Board appointed for such a purpose, would be to see that the rivers were not polluted. It would not be for them to carry out works to save the river from pollution, but rather to exercise a restraining jurisdiction.

3877. Do you mean that it would be their duty to see that the law was observed, and that they would force the Local Boards of the towns to carry out the works necessary for such a purpose?—I mean that they should have certain powers over the Local Boards of towns, to restrain them from polluting the rivers.

3878. Mr. *Ferrand*.] Have Local Boards summary powers at the present time to take land for tanks and reservoirs beyond their local districts?—I apprehend that they have such powers; they have not compulsory powers to take land, unless they get them by a Provisional Order confirmed by Parliament: they have powers to construct a reservoir; but in order to get the land for that purpose, if they cannot agree about it, they must have a Provisional Order, and any person can object to that, and can be heard before a Select Committee of Parliament with regard to it.

3879. A Local Board has now the summary power of carrying drains and sewers beyond its local district, through lands, to empty the sewage into the river: do you object to further powers being given to Local Boards to take lands for reservoirs and tanks when they have already those summary powers?—I apprehend that they have the power to construct reservoirs or tanks out of the district. There are two distinct things; the one is the construction of the works, and the other is the power of acquiring land for the construction of the works. They need not come to Parliament, if they can obtain land by agreement; but if they wish to exercise compulsory powers for the purpose, they must come to Parliament for those powers.

3880. What would be the expenses of that?—They would be very trifling, because it is done by a Provisional Order, which is incorporated in and passed with a general Act. It would not

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cost more than a few pounds; the expense is not worth mentioning.

3881. Have not Improvement Commissioners, under Private Acts, a power of fouling streams, not being prohibited from doing so by Act of Parliament?—There is no general Act prohibiting their fouling streams. They are subject to the common Law of Nuisance.

3882. Then does not the Local Government Act apply to Commissioners under an Act of Parliament?—Not unless they have adopted it.

3883. Therefore, at present, if a body of Improvement Commissioners, acting under their own Private Act of Parliament, foul streams or rivers, there is no penalty for their doing it; is that the case?—There is no penalty except a general liability to an indictment for nuisance, or an action at law, or proceedings for an injunction.

3884. Is it your opinion that Improvement Commissioners acting under Private Acts of Parliament, should be placed under the power and control of the Local Government Act?—From the experience which our office acquired under the working of the Public Health Act of 1848, we were led to the conclusion that it was a better principle to allow towns to adopt the new Act, and not to apply it as under the Act of 1848. In the Act of 1848 there was a power of applying the Act on a Provisional Order, or an Order in Council, upon certain provisions, even against the wishes of the town, but it was considered that it was better to give powers to adopt the Act; since 1858 that has been the principle, and I think that works better.

3885. Supposing that a body of Commissioners refuse to place themselves under the power of the Local Government Act, and are doing serious injury and damage to the public by fouling streams, do not you think that it is fair towards the general public that those Improvement Commissioners should be put under the Local Government Act?—I think that if the alternative is between applying a particular Act to a district, whether it will or not, and allowing that district to adopt that Act, all things being considered, the principle of adoption is a better one in this country, even admitting that some evils may follow from the unwillingness of any body of Commissioners to adopt the Act. If you suppose the question to be between a general Act, to apply everywhere, and an Act to be adopted or applied, I am in favour of a general Act applying everywhere. My own feeling or impression is that the existence of a town implies the existence of certain evils which require remedy, and I would like to see powers for the application of those remedies embodied in a general Act, which should be made to apply to every town in the kingdom. I would, therefore, like to see a Local Government Act of general application, but that is distinct from the question between application and adoption.

3886. Is it your opinion that a general Act would be fairer towards the general public?—I think so. I do not think that it is so much a question of local opinion as of sound general legislation.

3887. It is a question of national benefit, is it not?—It is a question of national requirement which I think ought to be met by a general Act.

3888. You have stated, have you not, that there is no difficulty in obtaining an injunction against persons for fouling a stream?—There is none.

3889. Do not the Courts of Chancery frequently direct trials at the Assizes to settle the amount of fouling which is caused?—Where there is a question as to the act of fouling, that is the case. A small amount of fouling might raise a very difficult question: but in the case of the sewage of a town being turned into a stream, I apprehend that there would be, practically, but little difficulty in obtaining an injunction.

3890. Would not the sewage of a good many villages, which, taken separately, would only be small, when all put into one stream amount to a very considerable quantity?—The contribution of each would be small, but the contribution of the aggregate would be large; there might be a difficulty there in taking proceedings, because you could not include them all in an one proceeding for injunction, so far as I know.

3891. Does it not very often happen now that a person who knows that he has no legal right to foul a stream sets up a right in the Court of Chancery, and that then the Court of Chancery directs an issue to try the question at the Assizes before a jury?—Yes; I am aware that that is the practice.

3892. Therefore, under those circumstances, is there not a difficulty in obtaining an injunction?—In any case short of that of pollution by the combined sewerage works of a town, I should think that there might be great difficulty, and there always is a great expense.

3893. Has not the general use of water-closets during these last few years greatly increased the pollution of streams?—No doubt water-closets are almost always introduced in connection with a general system of sewerage; water-closets are in connection with the sewers, and in connection with the water-supply of the town.

3894. Did you not suggest that one way of getting rid of the sewage was by converting the solid portion of in into manure?—That plan has been tried, but I am not aware that it has been tried with any success on an elaborate principle. The simplest and rudest mode of doing it has certainly been found to be the most practicable; as at Chelmsford, where they simply mix it with ashes, and sell it to the farmers for 1*s.* or 2*s.* a ton, which pays the Local Board for the expense of mixing it with the ashes, and helps them to defray the expense of carrying it to one point; and then they discharge the water, which has been disinfected with lime, into the river.

3895. If the sewage of towns were converted into dry manure, might not that very easily lead to adulteration of sewage?—No doubt sewage is always very much mixed, and it might be mixed to any amount.

3896. You have alluded to the difficulty that Local Boards have in putting a stop to the pollution of rivers and streams; do you see any reason why where persons pollute rivers and streams in a district where there is a Local Board, and where that Local Board refuses to act, private individuals should not have the power of summoning the persons who do pollute the streams before the magistrates in petty sessions?—Such a power might be appropriate in small cases, but it would not be suitable in any very large or serious case. The nature of the tribunal might be objected to by persons proceeded against; they might say that the interest at stake to be dealt with was too important; for instance, a large dyer discharging his dyestuffs into a stream might say, "My works are too important for me to submit to this jurisdiction, and therefore I prefer to go

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to the superior court"; and you would be interfering with a very large industry sometimes.

3897. But would you leave that to the Local Board?—The Local Board are themselves, in one sense, the great offenders; the Local Boards are always calling upon the inhabitants to get rid of their sewage, and to construct outfalls for it, so that they create the monster mischief, so far as pollution by excrementitious matter goes.

3898. At the present time, is it not the fact that no penalty can be inflicted upon any person for throwing a dead dog, or a dead sheep, or a dead calf, or anything of that kind, into a stream, even in the middle of the summer months?—In the case of streams that are under the control of Local Boards there is a penalty for such things being done.

3899. Do you know the amount of penalty?—The clause that provides for it is: "And be it enacted, that whosoever shall bathe in any stream, reservoir, conduit, aqueduct, or other waterworks belonging to or under the management or control of the Local Board of Health; or in any reservoir, conduit, aqueduct, or other waterworks, constructed, continued, or maintained under this Act in any parish or place in which there shall be no Local Board of Health; or shall wash, cleanse, throw, or cause to enter therein any animal, rubbish, filth, stuff, or thing of any kind whatsoever; or shall cause or permit or suffer to run or be brought therein the water of any sink, sewer, drain-engine or boiler, or other filthy, unwholesome, or improper water, or shall do anything whatsoever whereby any water belonging to the said Local Board, or under their management or control, or whereby any water of or contained in any such reservoir, conduit, aqueduct, or other waterworks so constructed, continued, or maintained in any such parish or place as aforesaid shall be fouled, shall for every such offence forfeit a sum not exceeding five pounds, and a further sum of twenty shillings for each day whilst the offence is continued, after written notice in that behalf."

3900. Mr. *Sclater-Booth.*] Does that refer to open rivers?—It would refer to rivers used for the supply of the town only; it would not apply to rivers generally.

3901. Mr. *Ferrand.*] But will you point out any Act of Parliament which inflicts a penalty for throwing dead animals of any kind into a stream which is not under the power or control of the Local Board?—There is none.

3902. Mr. *Adderley.*] What is the means of recovering those penalties which you have just mentioned?—By summary proceedings before the justices.

3903. Mr. *Ferrand.*] I understood you to state that Local Boards have authority to take lands, with consent, for the construction of sewage tanks and reservoirs beyond their district; have they the same power to take lands for the utilization or application of the sewage?—Yes, that power is given to them; the Act says that they may take lands on lease for the distribution of the sewage; and they have taken lands in that way at Croydon.

3904. If they required land, and were unable to obtain land by consent, would they be able to obtain it under a Provisional Order?—They would be able to obtain it under a Provisional Order; it would be one of the purposes of the Act.

3905. Do you think that, supposing there were two or more Local Boards upon one stream, it would be desirable to give one Local Board which was below the others a power to take legal proceedings against the other Local Board or Boards upon the same stream for polluting the river with their sewage?—I apprehend that such a power might be very useful sometimes; if you found them, for instance, applying the sewage on the land for the purpose of avoiding the pollution of the river, it would be necessary that some power should exist to stop the Local Board above from throwing their sewage down on the town below.

3906. Is there any such power at present?—There is no such power expressly given by any Statute, but I do not know that they might not exercise it as the local authority for the execution of the Nuisances Removal Act in the district; the Nuisance Removal authorities may, by the Nuisances Removal Act, take proceedings against the parties offending against that Act, and the Local Board might take such proceedings; but it is open to doubt, whether they could do this when the nuisance arose out of their district; they only have powers within the district.

3907. Do you think that it would be desirable to give such powers to Local Boards?—You want a more general authority; I mean to say, that really to protect the streams, you ought to have an authority over the whole watershed or catchment-basin.

3908. Sir *Joseph Paxton.*] Can you name to the Committee any place where the application of the sewage has been very successful?—I have not examined that question myself, not being an engineer or a chemist or an agriculturist; I rather confine myself to my own functions, which are connected with the administration of the Act and the legal part of the business, and therefore I should prefer not to go into that question.

3909. Do you think that it would be wisdom in Parliament to pass any stringent laws with respect to this question, until some well-devised scheme is laid before them?—I should conceive that in the present state of circumstances such legislation would be premature; that is to say, legislation to compel Local Boards to apply the sewage on land.

3910. *Chairman.*] Do you think that stringent measures are necessary to prevent their putting the sewage into the rivers?—Yes; but it is a question of policy as to whether such a measure should be passed to compel Local Boards to do that at present.

3911. Dr. *Brady.*] In order to enact some measures of that kind, how are you to prevent the rivers being polluted?—I do not see, at this moment, how you can prevent the pollution of the rivers.

3912. Sir *Joseph Paxton.*] Various schemes have been tried, and most of them have been failures, have they not?—Certain experiments are being carried out of great interest, particularly at Croydon; and at Carlisle also.

3913. Is the Croydon sewage pumped?—I do not think that it is pumped; I think that the land admits of its application by gravitation.

3914. Are you aware of what they do at Leicester?—I know that that was a failure.

3915. That was done at very large expense to the town, was it not?—Yes.

3916. It has certainly cleared the water, I believe, but it is a very large expense; but so far as agricultural purposes are concerned, are you aware that the scheme has proved of very little utility?

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utility?—I believe that the dry manure which was produced at Leicester was next to useless.

3917. Do you not think it would be wise, in the present state of the question, for moderate experiments to be carried on under various forms, in order to ascertain what is best, and to arrive at some good system for the application of sewage, before you deal with any of those large operations of law which would compel people all at once to divert their sewage and apply it in the same manner as at Leicester, where it is turned out at very great expense, and has been a very great failure?—I do not think that the question is in a state, so far as I am informed, in which Local Boards should fairly in sound policy be compelled to carry out any particular class of operations.

3918. Mr. *Bright.*] You have spoken of Local Boards; if I understand, right you have nothing to do with the powers of corporations throughout the country?—Not as corporations, but where there is a corporation adopting this Act they become the Local Board.

3919. Have you had any cases brought before you of the difficulties which corporations find themselves in with regard to this question?—We have not, except where they have been Local Boards involved in proceedings of the same class as those of which I have already spoken, injunctions to restrain the pollution of streams and so on.

3920. In regard to the town of Birmingham, have you had any facts before you?—We have not had any facts as to the town of Birmingham; the Local Board of Birmingham have not adopted this Act.

3921. Have you ever considered whether it would be advisable to pass an Act giving to corporations, the power of passing their sewage through open or closed drains for some miles, if necessary, from a town, and distributing it to the land if the farmers choose to buy it, and letting the clear water find its way into some more distant river, where it would not be injurious?—I have considered that incidentally; because the question would be precisely the same in the case of corporations as in the case of Local Boards. It was thought desirable to give Local Boards that power, and that is the object of the Local Government Amendment Act of 1861. We thought that they had that power by the Act of 1858; and when we found, by the case of Hayward and Lowndes, that they had not that power, we then introduced the Act of 1861, for the very purpose of giving them the power.

3922. In fact, would it not be advisable that they should have power forcibly to enter land, paying, of course, to the landowner compensation for any damage caused?—Such power seems to be necessary.

3923. Why should not that power be given to corporations?—They can at once acquire the power now, under the Local Government Act; they can adopt the necessary clauses of the Local Government Act, which contains a power of partial adoption, by which corporations can acquire all the powers they require simply by the vote of a majority of the Town Council.

3924. Not of the ratepayers?—No, it is by an act of the corporation; the Town Council adopt this act, and not the ratepayers. Where there is no governing body like a corporation, the Act is adopted by the owners and ratepayers; but if there is a governing body, in the shape of Improvement Commissioners, or trustees, or a Town Council, that body can adopt the Act, and it becomes the Local Board upon the adoption of the Act.

3925. Does it require that they shall adopt more of it than they want?—No; they can adopt the portion that they want.

3926. Mr. *Sclater-Booth.*] You have stated that there is no authority on the part of the public who are interested to enforce the provisions of those Acts, or to suppress the pollution of streams; is that so?—There is none, except what the Court of Queen's Bench can do by *mandamus*, and except also what the Secretary of State can do indirectly.

3927. Is it the case that all applications of the law must proceed from private individuals?—Yes.

3928. Is not that a defect of the law of England which runs through the whole of our law?—Yes; it is a characteristic of the law of England, that there is no central authority to go to in such matters.

3929. If you, as the legal organ of your Board, were authorised to do so, would you see any difficulty in your applying for a mandamus, or an injunction against individuals polluting streams over the whole of the kingdom?—I should find an excessive difficulty in that, because I should find myself most imperfectly instructed in any particular case. I should require a great apparatus; I should require inspectors, and I should require counsel, and I should require means of collecting evidence.

3930. Is it not possible that in that way you might have worse evils than are submitted to now by the public?—Yes; there would be an excessive amount of inconvenience from such a system.

3931. Does the Smoke Consuming Act come under your cognisance?—As one of the functions of the Local Boards, it does; they have certain modified powers with regard to the prevention of nuisances from smoke, but we have not powers to take or direct proceedings under that Act.

3932. Have you found that that Act is put into successful operation by individuals taking proceedings under it?—I cannot say, as I have no information on that point.

3933. Is it your impression that that Act has been a dead letter?—It is my belief that the enactment as to smoke is almost a dead letter, simply because the Local Boards are often the persons whom it most affects, and therefore they are the persons who are least likely to put it in force.

3934. Mr. *Tite.*] Would you apply that remark as to the Smoke Consuming Act to the metropolis?—At one time that Act was said to be carried out in the metropolis; it was in the hands of the police, and was said to be effectually carried out, and with great benefit. But I have heard it stated (I do not know with what truth) that since that time there has been a relaxation in the carrying out of the Act; I believe that the general impression is that the Act has done great good in London.

3935. Mr. *Sclater-Booth.*] Passing to the other question that you have raised, as to the advisability of the jurisdiction of a Local Board extending over a whole valley or catchment-basin, would your opinion be that such a Local Board as that should supersede the smaller boards or should absorb them?—I apprehend that it would be a distinct board altogether, upon which the smaller boards

boards would be represented. I suppose that in order to make such a board effective it ought to include the representatives of the great towns upon the streams and the centres of population, which are, in fact, polluting the stream; and that it should be either a board composed of delegates from those smaller boards, or, where there are not such boards, of persons elected by the owners and rate payers, so that it should be a board of supervision, so to speak.

3936. In order to give to such a board any power or importance, must you not provide it with a power of rating?—Certainly, if it is to take proceedings againgt offenders; for instance, it would have to take proceedings in chancery, and it would have to set the law in motion.

3937. Do you not think that there would be great clashings and jealousies of interests between such a board as that, and the Local Boards of the towns?—No doubt you would have difficulties in the working.

3938. Would it not be almost as bad, if I may use the expression, as an interference on the part of your office without the advantage of being completely a central authority, so that it would be a tendency towards centralization without such centralization being effective?—If the evil is one of sufficient magnitude to require being met, I do not see any other way of meeting it but that.

3939. Mr. *Adderley*.] Do you understand that the powers which are given by the Acts of 1858 and 1861 for Outfall without the District, give the Local Boards those powers to any distance, or what would be the limit of the words, "without the district"?—I think that they are not limited; except, of course, by the practical necessities of the case. A Local Board would never carry their sewage further than they could avoid, because of the great expense attendant upon the construction of the necessary works.

3940. There is, at this moment, a place at Birmingham for carrying the sewage of that town 10 miles down the valley of the river. Would that be within the meaning of those Acts?—Provided that the works are continuous I do not think that there is any limitation of distance.

3941. Is it not the case that places that have not adopted the Local Government Act have still some body which may be proceeded against in case of a nuisance, and a body which is responsible for that nuisance?—Towns of a certain size have generally a body of Local Commissioners.

3942. Even if there are no Local Commissioners, is not the Board of Guardians the body which is responsible, and which may be proceeded against in case of a nuisance?—The Board of Guardians is the nuisance removal authority in the absence of any other body. They have acquired that position under the Nuisance Removal Act.

3943. So far as nuisance removal goes, is it the fact that there is no case in which there is not some responsible person, or some person who is legally liable?—There is everywhere a local authority for execution of the Nuisance Removal Act. But Boards of Guardians are not now vested by the Nuisance Removal Act with any powers of carrying out a system of sewerage, and therefore there would not be a violation of duty on their part in not taking proceedings against individuals for polluting streams; you could not say that the Boards of Guardians were violating their duty because they did not provide for the sewerage of their district.

3944. You have expressed a strong opinion against reverting to the old cesspool system; do you know of any recent proposals for a cesspool system on an improved plan, such as at Nottingham, which might not be liable to the objections which were made to the old cesspool system?—I do not know what is the nature of the Nottingham proposals.

3945. The observations which you made applied to the old cesspools; do you not consider that it might be possible to construct cesspools on a different system, to which those objections to the old system might not apply?—I suppose that it might be possible, but I imagine that the great objection to such a system would be the cost. There has been a proposition, I believe, at Manchester, by some company called the "Eureka Company." The town clerk of Chester told me that they proposed applying a system of improved tanks for the reception of the excrement, and then carrying it off and converting it into manure. There is such a company, I believe, in course of formation, but I do not know whether or not it is in action; I have been informed that they have published a pamphlet showing that the matter resulting from their operations would be of great value as a fertilizer, and that they propose to sell it for 6 *l.* a ton; I think that in fact they were going to make a sort of guano of it.

3946. Have you any powers in your Local Government Office, and do you exercise any powers to inspect cases in which Local Boards fail to do their duty, or to compel them to take steps for doing their duty?—We have no such power.

3947. You have inspectors, have you not?—We have inspectors.

3948. Have you not complaints made to your office from Local Boards?—Very frequently; the only steps that we take are rather extra official; I always in those cases write to the Local Board respecting the complaint that has been made, asking them to give us information on the question, so as to let them know that a complaint has been made, and that there is somebody taking an interest in it; they state the circumstances of the case according to their view, and in many cases it leads to something being done by which the matter is arranged, but we have no real authority.

3949. Have you any power either to proceed against them or to facilitate their taking steps themselves?—No; we have no real power over them.

3950. Did I rightly understand you to state that you think that it would not be advisable to give your office such powers, but rather to look to giving powers to new Boards, representing groups of Local Boards?—I think that there would be very great difficulty in a central authority exercising beneficially or fairly such powers as would be requisite, from the necessary want of information; it would be a sort of moveable court, and we should have to go about and become a sort of Justices in Eyre; we should want a great judicial force for the purpose.

3951. Mr. *Cowper*.] The action of the Local Boards in removing decomposing matter from the vicinity of houses, has generally led to the pollution of rivers, with the exception of Croydon and some other cases; do you consider that before effectual measures can be taken to prohibit the polution

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pollution of rivers by sewage, there must be some means of applying sewage to agricultural land, which shall be generally admitted to be profitable and advantageous?—Before you could legislate generally and stringently on the matter, I should think that that would be necessary.

3952. But supposing that it were generally admitted that the sewage of towns could be advantageously applied in agriculture, do you think that a Catchment Board, whose special duty it should be to protect the rivers, might work advantageously?—If any system could be proved to be applicable generally and profitable, that would be so.

3953. In that case there would be the antagonism; the Local Boards would be endeavouring to protect the air from being polluted by the sewage, and the Catchment Board would be endeavouring to protect the water from pollution, if those two both succeeded, would they not compel the third course to be taken, of the application of the sewage to agriculture?—Yes.

3954. Would it be necessary in that case that such a Board should have any considerable rating powers?—I should think that their rates ought not to be large; the rate over a large district would be a very trifling rate I should think. I understand that the Board should merely exercise a supervision, that they should be empowered to say to a Local Board, you shall not carry your sewage into the water.

3955. Supposing that this suggested Board were not to execute works, but merely to exercise a supervision, would they, in that case, require to incur any large expenses?—It is difficult, of course, to say what legal expenses they might be led into. In that case their expenses might become heavy, but you might take steps to interpose some check upon that.

3956. Mr. *Adderley.*] Would not their only expenses be inspection and legal proceedings?—Inspection and legal proceedings would be their sole expenses. They would require an office and a clerk, I suppose; but I should think that useful evidence on that point might be obtained from what is found in the cases of the Great Commissions of Sewers.

3957. Mr. *Cowper.*] In that case, do you think that the functions of this Catchment Board would be so similar to those of the Local Boards as to create any confusion in the minds of the ratepayers?—I should think that the two functions are as different as anything can be well conceived to be. The one is a Board for seeing that a certain thing is not done, and the other is a Board for carrying out works.

3958. If such a Board as we have been alluding to were created, is it your opinion that it should extend throughout the whole boundary of the water's bed?—I apprehend that to be effectual in its action that would be necessary, because the pollution of any one of the streams within that area would tend to the pollution of the main stream, und unless you can secure the whole of that area it is useless to purify any part of it.

3959. Would it be necessary for such a Board to protect the river against every sort of pollution coming from manufactures, coming from wanton acts and individuals, as well as from the combined action of the sewerage of the town?—Subject to the general principle, *De minimis non curat lex*, it would, because many manufactures, for example, cause quite as serious pollutions of streams as Local Boards do.

3960. Do you think that it would be fair that their rating powers should be exercised over the whole of the watershed district, or that they should be confined to the particular district which is suffering from the nuisance?—I think that you would have to give them powers of dividing their district for rating purposes; they should themselves have some authority to determine their district and rating areas; as a rule, I should think, their rates would be excessively small, unless, in the case of expensive legal proceedings against particular manufacturers or Local Boards, when their rates might be heavy.

3961. Mr. *Bright.*] Would you consider a Board, such as you speak of, to be necessary for London?—London is a case apart, and I should rather not attempt to speak off-hand upon that. We suppose that London, in the next few years, will be relieving the Thames from its own sewage at least, and then what London would have to look out for would be that the towns above it, in the valley of the Thames, did not pollute the river.

3962. *Chairman.*] Did you not give an instance which proved that the Local Boards had not weight enough, but that rather than be enforced by injunction to carry out the law, they are themselves crushed by those injunctions?—We have seen the case of a Local Board being crushed, where they have, not very wisely I think, waived their functions altogether.

3963. Those smaller Local Boards appear then to be ineffective for the object which you have in view; is not a Board of greater weight required for that object?—A Board of entirely different construction and different character altogether is required.

3964. There is a difference between your opinion and the opinions which have been given by other witnesses on this point; other witnesses have agreed that there should be a Board for each water-shed, but they have said that this Board should carry out the necessary works, and that a central authority in London should put them in motion, and see that they enforced the law; if I understand you rightly, although you agree with them that there should be a Board for each water-shed, yet you are of opinion that it should be that Board which should see that the law is put in force, and that the Local Boards should carry out the works; is that the difference between you and the other witnesses?—That is substantially the difference.

3965. You conclude the pollution of rivers to be a great evil, do you not?—I believe it to be a great evil.

3966. Then is it your opinion that it is necessary, for the sake of the public health, to prevent the pollution of streams?—I am not aware that the pollution of streams has, at present, gone to such an extent as to be a grave detriment to the public health, but it is a growing evil.

3967. Do you agree with the Commissioners in stating that it is an evil of great national importance?—I apprehend that it is, because it is a growing evil, and is, I fear, in course of growth to very serious dimensions.

3968. Then do you consider that it is absolutely necessary that sewage should not be allowed to run into streams and rivers?—That is the only way of preserving streams from pollution.

3969. Is not filtration ineffective and useless for that purpose?—I presume that it is from the evidence.

3970. You

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3970. You have stated that the only alternative, if you may not put the sewage into the rivers, is to put it on to the land, is that your view?—That is the only real alternative; you may palliate the evil by stopping your solid matter, and treating your liquid with some kind of deodorizer.

3971. But that does not entirely remove the evil, does it?—It may prevent the rivers from being clogged with a quantity of excrement, which lodges on their banks, and makes the water foul and offensive; but liquid which has been treated with lime, or carbonic acid, or with any other deodorizer, although I believe, practically inoffensive, is not really pure.

3972. Then to say to a town "You shall not infect the river," is as much as to say "You shall put the sewage on the land," is it not?—It comes to that in the long run.

3973. In your opinion the utilization of the sewage on land should not be regarded as a commercial speculation, but should be carried out whether it pays or not?—If you once begin to legislate on the subject, I presume you must so consider it; but at the same time I would guard my answer by saying that it is a very grave question whether you should begin to legislate on the subject until you have ascertained that some system of utilization may be adopted at something like a profit.

3974. Supposing that it has already been proved to the Committee, by witnesses who have been called before them, that the law is sufficient for the purpose, and that it is contrary to the common-law and to the Acts of Parliament to allow the sewage to run into the rivers, by enforcing that law are we not, in fact, saying to the towns, "You shall apply the sewage to the land"?—Practically, it comes to that.

3975. If any towns have made up their minds that it will be an advantageous commercial speculation so much the better, but it must be done even if it does not prove successful in that respect?—That would be so, if you ever begin.

3976. Mr. *Ferrand.*] Have you ever heard of the application of sewage to land producing diseases or being injurious to the health of the people in the neighbourhood?—I have heard of many applications of the sewage, but I never heard of injury to health from it.

3977. Mr. *Hibbert.*] The Local Government Act cannot be applied to towns below a certain population, can it?—Except with the sanction of the Secretary of State, with special circumstances shown, the Local Government Act cannot be applied to towns with a population of under 3,000, but above that towns can adopt it at will.

3978. So that, with the sanction of the Secretary of State, it might be applied in small parishes?—It is applied; that restriction was only introduced in the Session of 1863.

3979. Who are the parties now in small parishes who have the power of the removal of nuisances?—The Board of Guardians, in failure of any other authority; in some cases, in rural parishes, they have elected a Nuisance Removal Committee for a certain period, and have got that Committee to work, and appointed an Inspector of Nuisances, and then that Committee is the authority; but that is the case in very few instances; in the great majority of cases the Board of Guardians is the authority with regard to nuisances.

3980. Is it not the case that the Nuisances Removal Act is almost inoperative, and that very little is done to remove nuisances?—We have a great many complaints, but a good deal is done I think also.

3981. Do you think that it would be desirable to have an authority in parishes who should have some of the modified powers of the Local Government Act given to them?—It is a question of great difficulty, because you find that, practically, it comes to be the same persons as compose the Board of Guardians; you cannot find a class all over the country who will take an active intelligent interest in matters of this kind. The great bulk of the local authorities are composed of the same class of people, and they will think first of the expense. I imagine that whatever your local authority were called, it would be composed of very much the same class as now constitutes the Board of Guardians.

3982. Is it not the fact that very little is done for drainage and for the removal of nuisances in small parishes?—Very much less is done than ought to be done.

3983. Does not that necessarily increase the amount of disease in those parishes?—No doubt, but I do not see my way to remedy that evil.

3984. Mr. *Ferrand.*] One river may be in two or three parishes, or in two or three counties, may it not?—Yes; the catchment-basin is quite irrespective of any division which already exists. A map was prepared by Mr. Rawlinson, for the convenience of the Sewers Commission, showing the catchment-basins of the whole of England.

Robert Rawlinson, Esq., called in; and Examined.

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3985. *Chairman.*] You are a Civil Engineer, are you not?—Yes.

3986. Were you Superintending Inspector under the first Board of Health in 1848?—Yes, I was.

3987. Were you Engineering Sanitary Commissioner to the British Army in the Crimea?—I was.

3988. And you are now a member of the Royal Sewage Commission appointed in 1857, are you not?—I am.

3989. Are you also the Principal Inspector in the Local Government Act Office?—Yes.

3990. And you are Engineer under the Public Works Act, passed in 1863 (last year) for Lancashire?—Yes.

3991. And a member of the Barrack and Hospital Commission for the British Army?—Yes.

3992. As you are on that Sewage Commission, have you inquired into the pollution of streams in various parts of England?—Since the establishment of that Commission, I have personally inspected most of the places, up to 1863, where any sewage works have been carried out, as also where liquid applications have taken place to land. I have also inspected the rivers of Lancashire, and a portion of the rivers of Yorkshire, from their estuaries to their source, to investigate the amount of pollution.

3993. Are those streams so far polluted, do you consider, as to be injurious to the health of the towns which draw their water-supply from them?

—Most

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—Most unquestionably; the rivers of this country, when we speak of them as polluted for a water-supply, are in a most lamentable condition. For instance, take the Thames. A recent Act of Parliament compelled the water companies to withdraw their works from the place where they formerly were in this neighbourhood (viz., Lambeth and Chelsea), to above Teddington Lock; but above Teddington Lock there is a pollution by the sewage from not less than 800,000 people. Then, with regard to Lancashire, most of the rivers are fouled almost from source to estuary.

3994. Is there not a sort of mud deposit from sewage in the bed of the rivers?—There is a large amount of solid and flocculent matter, which causes a great amount of mischief; it putrifies on the banks.

3995. Would not that injure the town itself which allowed the sewage to run into the river?—It is injurious; but it is not injurious to the extent that the eye would judge it to be.

3996. Besides which, the towns lower down on the river are injured by the dissolved matter of the sewage, which they drink with their water-supply, are they not?—That is so. But the Lancashire towns, as a rule, do not take the water of rivers after pollution. Reservoirs are very extensively constructed in Lancashire and Yorkshire, and the water-supply is generally taken from upper branches of streams before pollution takes place; and then, when a reservoir has been formed, there are stringent clauses which prevent subsequent fouling of any water used for domestic purposes.

3997. Then are the streams so bad that they cannot drink them; so bad that they also foul the air and breed epidemics?—We have made a patient and careful house-to-house investigation in some of the worst districts of Lancashire (Manchester, on the banks of the Medlock, for instance), but we failed to establish any great excess of disease from river emanations. We found that the cesspit or cesspool retention was far more injurious than anything that we could trace to the open rivers.

3998. Are cesspools very extensively used in Lancashire and Yorkshire?—Yes, common privies with cesspits, common to cottages all through Lancashire and Yorkshire.

3999. Then if they begin to make sewers and drain the cesspools or cesspits into the rivers, the rivers would get a great deal worse than they are now, would they not?—One can hardly imagine the streams and rivers ever being worse than they are now; they are very much worse than ever the Thames was.

4000. Mr. *Bright.*] Are they so bad from the causes which are supposed to have made the Thames bad, or are they discoloured and offensive from the refuse of dye-works and manufactories, and not from the sewage?—The greater discoloration comes, no doubt, principally from dye-works and chemicals, but the rivers Irwell, Medlock, and Irk, and the Bridgewater Canal are more offensive from sewage proper than ever the Thames was, because they are so much less in volume; and although you have no Lancashire town where sewers and waterclosets are so extensively used as they are in London, yet you have a sufficient amount of sewage, as compared with the volume of water, to make them worse. For instance, in Manchester, cottages have not got water-closets, but all the hotels and larger houses have waterclosets, and all such sewage passes directly into the local rivers.

4001. *Chairman.*] Are those cesspools which they have in Lancashire mere open pits?—A common privy is compelled by law to be provided, and there is an open space behind, into which ashes and other refuse are thrown, and into which soil-refuse drains; I believe most of the cesspits are roofed over, and that rain-water is kept out.

4002. Do they pollute the air to a great extent?—They pollute the air to a great extent, because they are crowded immediately behind living-rooms and sleeping-rooms; many hundreds of them are in contact with cottage walls, and the foul matter oozes through the walls and taints the air inside.

4003. If that were flushed into the streams through sewers, the streams would be worse, if possible, than they are now, would they not?—They would be fouler than they are now, and now they are very obnoxious.

4004. This mud deposited from the sewage in the streams gradually silts the streams up and destroys the scouring power of the water, does it not?—That, together with other matters, produces that effect. At present, with the exception of a conservancy Act, which was obtained by the Bridgewater Trust, and which is not as yet efficiently worked, every man owning a frontage on a river, either in Yorkshire or Lancashire, as also in other parts of England, does what seems best to him; he tips his refuse or ashes, or, if he is digging foundations, he tips the soil into the river, and in fact does what he likes with it, and abuses the stream with it as he thinks proper. There are river-beds in Lancashire and Yorkshire which are raised 10 or 15 feet above their former level, and there are bridges under which now a dog can scarcely creep, and I have had evidence from inhabitants that they have driven loaded carts under those same bridges.

4005. Is not that practice injurious to the surrounding country?—It is so, and certainly to the parties themselves, because they are destroying that which is bringing trade to the place.

4006. Mr. *Bright.*] Has not all this happened where there is still a sufficient fall for the water?—It is not so. In Lancashire and Yorkshire many scores of acres of ground become inundated, because the bed of the stream lifts the flood above the adjoining land; and then the person who has done the mischief is not responsible for that, and does not care anything about it.

4007. *Chairman.*] The streams about Birmingham have silted up many feet, have they not?—Many of the streams in the valleys near Birmingham, and within the borough, have; and large areas of property have been deteriorated by the silting-up of the streams and the flooding of the valleys.

4008. Damage is inflicted in Birmingham now on any extra rainfall, is it not?—Yes, to the extent of thousands of pounds.

4009. If this evil is already so great, and is liable to become greater every day (as the sewage of towns is likely to be carried out), does it not appear to you that this is a fit subject for legislation, and that some efficacious remedy ought to be applied?—I think so, certainly, for the safety of all parties, and for their welfare as well, because individuals and even towns are at present helpless.

4010. Is it not the case that this evil has only begun within the last 30 years?—The abusing of the streams has gone on from time immemorial. The great fouling by water-closets' refuse of course is of a comparatively recent date; since 1840.

4011. Till then each town kept its own filth to itself, and then applied it on the land?—It is not quite so, because, in the cases of many towns that never had water-closets where a stream ran through, the privies and other conveniences were placed over the running water, or parallel with it, so that there was a certain amount of fouling in the remotest period.

4012. But still, as a general rule, they kept their filth to themselves, and applied it to the land in former days; is not that so?—I am not aware whether it was always applied to land or not; the filth generally putrified and passed away, as it does now in many instances; it lay on the soil in the vicinity until the rain diluted it, and the sun dried it.

4013. Can you give the Committee any information as to the case of Salford; is it true that they wished to undertake works at an expense of 80,000 *l.* to distribute their sewage over the land, and that they were prevented from doing so by the refusal of other towns to co-operate?—I do not remember rightly the estimate; but a scheme for intercepting the sewage proper was matured by a Committee of the Town Council of Salford; they proposed to take it down by a tunnel some three or four miles out of Manchester, on the banks of the Irwell, and there, in some manner or other, taking out the solids or otherwise, they were to use it beneficially upon the land; that scheme has fallen through by opposition in the town council: they say, "What is the use of our expending this large sum of money when Manchester and all the towns above will continue to foul the rivers; we shall receive the filth of all our neighbours, and be no better for our expenditure."

4014. Then, was it the want of unity of action between the town or the river that made that good intention come to naught?—No doubt; and it must be always so. What is the use of Salford purifying the water, if Manchester and all the towns above send filth down to them.

4015. Then, in fact, taking filth into the river only removes the filth from the town itself, and puts it upon the shoulders of the town lower down?—Yes.

4016. You state that in London we drink the sewage of some 800,000 persons?—That is so.

4017. Are you aware that filtering is ineffective and cannot free the water entirely from fœcal matter which is contained in solution?—Chemists I understand say that filtration does nothing but strain out the solids, and that it does not touch any chemical combination.

4018. So that even after it has been filtered the water is sufficient to breed fever and may putrify in time?—I assume so, if the amount of foul matter exceeds a certain proportion to the volume of water.

4019. Is it not the fact, that pollution which is not perceptible to the eye may be very injurious to the health?—I cannot answer positively; I only know that I have received evidence of the most contradictory character as to the injurious effects of water. I have been told that a certain well was most celebrated in the district, and that people came half-a-mile to get the water, and a chemist, after analysis of such water, told me that it was absolutely poisonous.

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4020. Mr. *Caird.*] Did that people die of drinking it?—I did not obtain any such evidence in this case. Dr. Angus Smith made investigations in Manchester, and he told me this, that one well was so near to a cemetery that there was a perceptible fatty scum upon the surface in the morning, and when evaporated there was an absolute residuum of animal matter, which, on burning, produced foul gases, and yet the parties in the vicinity drank it and did not complain, and some of them thought that it was very excellent water.

4021. *Chairman.*] Are not the roots of plants the only perfect purifier of water that has been discovered?—Yes, or very deep drainage through a vegetable soil or through porous ground; a soil producing vegetation appears to purify water much more rapidly than sand filtration; in fact, filtration is an utter failure for sewage water upon any scale similar to the filtration of water works.

4022. Mr. Austin, in his report to the Board of Health of 1857, states that there is a circle of life, decay, and re-production; that putrifying matters are the elements of reproduction, and that if those are not employed to fertilize the plants they breed disease and death; do you agree with him in that opinion?—I scarcely go so far as that; I do not know what filtration through a large area of sandy and gravelly subsoil might effect where there was no active vegetation. I believe that active vegetation and an appropriate soil best abstract the sewage elements; but, as I say, I have failed to get any positive or strong evidence as to the injurious effects of sewage in an open stream. All the evidence that I have been able to obtain shows that if you dilute sewage to a certain extent, and especially if it is in a flowing stream, you have reduced the evil, as regards human health, to a minimum; but then the question of drinking such water is another element in the problem altogether.

4023. Is it not injurious if you drink such water, even though the pollution is not perceptible to the eye?—If you take the case of London in 1859, when the Thames was so fearfully foul, and its condition such as to kill fish by thousands, the mortality of London was not perceptibly increased by the foul state of the Thames.

4024. Was the state of the river chiefly due to the sewage of London?—It was; there had been a very dry spring, and the temperature of the water was higher than usual.

4025. In that case, if it was due to the sewage of London, it could not affect the water supply of London, which was taken from above?—All I mean is that the foul atmosphere of the Thames, which was so perceptible as to make these Committee-rooms unbearable, failed to affect the health of the metropolis in any serious degree.

4026. But still, if there is sewage in the water supply of a town, will it not affect the health very seriously?—There is a report as to the condition of Lambeth and Chelsea water-works, when one company changed its source of supply, and another company continued to draw its supply as before from below the bridge, and the amount of cholera was double in the foul water district what it was in the one which had changed its source of supply. Previously in a cholera outbreak the mortality was parallel in the two districts, and nothing had been

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been done in the one but removing the pumping establishment higher up the river, the other retaining its original supply, and there was a decrease in the district having the purer water supply of more than one-half of the mortality.

4027. Do you know anything of the Uxbridge case?—I must have seen it, but I do not remember anything at all of it.

4028. At Tottenham the sewage used to be turned into the stream?—It is so now.

4029. Was not there a law suit about it?—I believe there was, but I do not know anything about the law suit. I only know that there is no other place for the sewage of Tottenham except the River Lea. They erected sewage works (which have been utterly abandoned) for converting the solid matter into manure, for which they expected to get 4*l.* a-ton. Those works utterly failed, and they were discontinued; but there are works now for taking out the solids, mere depositing tanks, and for liming the water so as to pass it off bright in appearance, and it is purer in appearance than the Lee water into which it goes.

4030. Was the erection of those sewage works the result of the law suit?—I think, in the first instance, it was undertaken by Mr. Dover as a private speculation.

4031. At Leicester there was a law suit to compel the town to prevent their sewage from flowing into the river, was there not?—I am not aware as to the law suit; I saw their arrangements.

4032. Do they not grant their sewage to a company?—They do; and that company raised a very large capital, upwards of 40,000*l.*, it has been reported; there were 17 steam-engines for pumping the sewage.

4033. What were the purposes for which that company was formed?—It was for liming the sewage, and converting the solids into portable manure.

4034. Mr. Lawes, in his evidence on the River Thames, has stated, that the processes of deodorization at Tottenham, at Leicester, and at Croydon have completely failed; is that the case?—I believe they did, commercially.

4035. Can you tell us anything about the Bristol case, in which an action was brought in the Court of Queen's Bench against the Clifton Union?—No, I know nothing of that case.

4036. Is it the case that the sewage works its way up a tidal river above the point where it is let fall into the river?—I have no evidence of that, which I have myself obtained. I am only acquainted with the experiments which have been made on the Thames, and there the result, as shown by the floats, is, that although you have a down flow of seven or eight hours per tide, there is only an actual forward motion of about one mile in 24 hours.

4037. Mr. Lawes has stated, in his evidence to the Committee that sat upon that subject, that if sewage were discharged at Barking Creek, it would return to London; do you agree with that?—I do not know how far the flood comes back.

4038. So that the sewage, if discharged into the river, may flow down with the outgoing tide, and come up with the rising tide, and upon the whole there is only a mile gained?—If you have a down-flow of tide of 10 miles, the in-flow of the tide will bring the floats nine miles back; and therefore you have a sort of oscillating motion going down on the Thames. You are going a mile in 24 hours, so that if you know the number of miles you are from the sea, according to those float-tests, it will be so many days for so many miles.

4039. Besides that, do not numerous streams enter the Thames, which streams are already surcharged with sewage?—Yes; there is the river Lee, for instance, and other tributaries of the Thames.

4040. Besides that sewage, we have the sewage of Kingston, Teddington, Twickenham, Richmond, Oxford, and other places on the Thames itself?—Yes, that constitutes the 800,000 people whom I have mentioned above the point at which the companies are compelled to draw their supply of water.

4041. There are somewhere about 50 towns, I believe, on the Thames and its tributaries before the water reaches London?—I believe there are.

4042. The Wandle receives the sewage of Croydon, Carshalton, Mitcham, and other places, does it not?—Yes.

4043. And that is discharged into the Thames at Wandsworth?—Yes. The Croydon Board now pass their sewage over and through land before it passes into the Wandle.

4044. That is not the case with Beddington, Carshalton, and Mitcham, is it?—No.

4045. The Ravensbourne brings the sewage of a great number of towns and villages into the Thames, does it not?—I had an inquiry at Woolwich some years ago, and it did at that time. The greater portion of the Ravensbourne was taken for the supply of that district with water.

4046. Does not the 11th and 12th Victoria, chapter 63, apply to these places?—We have put the Act in force, but not in any way to prevent the fouling of streams; it gives them power to carry out works, and there leaves them.

4047. Then, in fact, while the metropolis is freeing the river from their own sewage, they are obliged to endure the sewage from all those places?—Just so; and you will continue to have it, and to have it in an accumulated form, because Oxford has recently adopted the Local Government Act, and no doubt the city of Oxford will set itself to work, and the sewage will pass into the Thames.

4048. The River Tame, which passes by Birmingham, is quite a small stream, is it not?—It is comparatively a small stream.

4049. Before it reaches Birmingham, above Birmingham, does it not receive the sewage of 270,000 people?—Yes, and all the refuse of gas works, chemical works, pumpings of coal mines, and the drainings of that great district of South Staffordshire.

4050. Is it true that your Commission have stated that that river contains as much sewage as water?—In the extreme dry weather flow I dare say it is so. It is a very bad water.

4051. Is there not a deposit of some 25,000 tons a-year in the Tame, at Birmingham?—The Birmingham people have made depositing tanks, and the sewers of Birmingham are drained into those tanks; and I think some three or four years ago the local surveyor told me that they took out not less than 25,000 tons per annum, or at that rate.

4052. But the sewage water flows into the Tame, does it not?—The effluent water does, that is, the water after depositing its solid matter, passes into the Tame.

4053. Whence does Birmingham obtain its water

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water-supply?—It obtains it partly from the Tame, above Birmingham, and from some gathering grounds in that district; they are now sinking some wells in the new red sandstone rock, but Birmingham is very partially supplied with water.

4054. The most of what they get is from the Tame, is it not?—I think they rarely touch the Tame now, except in extreme cases; they take it from a purer source.

4055. Mr. *Bright.*] Is it not the fact that Birmingham is reputed to be one of the healthiest, largest towns in the kingdom, and that the cholera, while prevalent in many other places, never visited Birmingham?—It is true that Birmingham never had such an outbreak of cholera as Wolverhampton and Bilston; but it always suffers more or less from a type of fever. The mortality of Birmingham is much higher than that of the Metropolis.

4056. Mr. *Adderley.*] Are you aware that Birmingham is not so healthy now as it was?—It has been deteriorating since my inquiry in 1850.

4057. *Chairman.*] The rivers in the basin of the Mersey are in a very foul condition, are they not?—The rivers in the basin of the Mersey are very foul, necessarily, from the vast mass of population on their banks.

4058. In your report you state that the Medlock, at Manchester, is covered with a black scum so thick that birds are able to walk over it; is that the case?—That is so. I know, as engineer to the Bridgewater Canal, that the abominations in the Medlock and its tributary rivers are so great that words would scarcely convey what it is.

4059. Mr. *Bright.*] Is the Bridgewater Canal partly supplied from the Medlock?—The Medlock was the prime source of water-supply.

4060. And that canal, as I understand, is offensive very often in hot weather; is that so?—Yes, very.

4061. Was it shown that there was any mortality from cholera along its banks, or has there been observed to be any disease that does not prevail elsewhere amongst the boatmen employed on the canal?—No. I think I stated previously that my investigation had failed to establish any excess of disease on the banks of those foul rivers, where they are left perfectly open.

4062. Did you not speak of the rivers of Lancashire and Yorkshire, and not of that particular one?—In the case of that particular river (the Medlock) there was an examination from house to house, for the special purpose of ascertaining that fact. We failed to establish any charge against the river of materially increasing the mortality, but there are still a great number of complaints as to the nuisance and misery which it occasions.

4063. *Chairman.*] The River Aire, which passes through Leeds and Bradford, is stated to be as bad as the Medlock; is that the case?—It is very foul.

4064. I believe the mud which is deposited in that stream is raised up by the floods, when they come down, and stinks and putrefies for a long way down the river?—It is so. The facts appear to be these, that in those rivers in Manchester the sewage matter combines in some way with the subsoil, and fermentation takes place; you see the gas rise up in a bubble, and a mass of scum with it, which cakes on the surface. You might skim the Bridgewater Canal at Manchester, and cleanse it completely every four-and-twenty hours; and this process of putrefaction with the subsoil takes place, and raises this scum, and again cakes and covers the surface.

4065. When those rivers are low the mud putrefies in the sun, does it not?—Yes.

4066. So that both in winter and summer they are in a most offensive condition?—It is so.

4067. Is it not the fact that the Clyde, which receives the sewage of Glasgow and other towns, is so bad and foul that 100,000 cubic yards daily sewage is deposited?—I do not know the amount. The Clyde is worse than the Thames, or than the rivers of Lancashire, inasmuch as it meets with salt water, and I understand that the chemical combination of salt water with sewage liberates a gas which is more offensive to the smell than where sewage is diluted with fresh water alone.

4068. Is it the case that at Greenock they spend 8,000 *l.* a year for dredging this deposit?—I do not think it could be proved that they spend so much as 8,000 *l.* a year for dredging the sewage deposit in the river. That is one of those cases where, to maintain the navigation, you must dredge under any circumstances.

4069. The sewage of Bath, I believe, makes a great deposit in the River Avon, so much so as to impede navigation; can you speak to that?—I have not examined Bath.

4070. If the present law is sufficient to forbid the pollution of streams, how is it that the law is not enforced?—The law is not sufficient. There is no law actually to prevent such pollution of streams, for instance, as takes place in Lancashire; at least I do not know of any law other than the Bridgewater Trust Act.

4071. Is it not contrary to common law?—I am not a lawyer; I do not know. I think that any person entering an action against any of the towns or any persons for fouling rivers would find that he had his labour for his expense, and that he would get no beneficial result.

4072. In your opinion, as an experienced engineer, if the landowners and farmers would bind themselves to take regular supplies of sewage, would it be worth while to construct works in order to convey the sewage to them?—There are so many contingencies connected with the application of sewage, that each case would have to be considered on its own merits; and whether it would pay, or whether it would be a matter to be paid for, would entirely depend upon local peculiarities. I can conceive of many cases where it would pay to apply the sewage to land. I know of some cases where I think it would be necessary to subsidise, if that was enforced upon a town; there may be conditions where localities might have something to pay to enable the sewage to be so applied.

4073. Some engineers have given it in evidence before the Committee, that the carriage of a substance, clay for instance, by suspension in water is cheaper than to carry it in a cart; is that so in your opinion?—I have no doubt about it.

4074. Then if it were remunerative to remove the matters of the cesspools to the land in former days by means of carts, will it not be still more remunerative in these days to remove it by means of suspension in water through mains, and with pumping engines?—There is no doubt about it; you can pump by those engines in the Lambeth Works, which stand almost opposite this House, I believe, above 80,000 gallons 100 feet high, at a working cost (including coals, tallow, and wages) of

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of 1*s.*, and you would lift sewage on a large scale for the same money.

4075. If all that sewage were diverted from the rivers to the land, the health of the inhabitants would be very much improved, would it not?—I think it would.

4076. So that it would be worth while doing it even though it should cost money to do it and it should not be remunerative?—I do not think that health is so much involved as questions of right and cleanliness. As I stated, the injurious effects of sewage appear to be at their minimum when it is in an uncovered open watercourse, and at the maximum when it is retained in the vicinity of a house, where fermentation can take place; you greatly diminish fermentation directly you pass it into an open stream that is moving.

4077. Did your hear Mr. Taylor's evidence with regard to the watershed boards?—Yes.

4078. Are you inclined to give an opinion upon that matter?—I think that if you are to do any good, practically, in the prevention or diminution of the present evils, you must have some form of action which shall take cognisance of an entire watershed. It is quite clear that you have no organization in existence now, so far as I am aware, in Corporations or in Local Boards, for dealing with anything but their immediate area. You have no machinery for dealing with a watershed as a whole, and therefore to improve any part of that watershed, and to leave the rest to take its course, would be the work of Sisyphus; your work, in separate towns, would come back upon you.

4079. Do you consider that there must be some unity of action throughout each watershed?—I think so, decidedly; not only as regards the sewage, but for other matters, such as the filling up and fouling of natural streams.

4080. Could that be procured in any other way except by a Board whose powers should extend over the whole catchment basin or watershed?—You cannot set up in this country a centralized authority, as in France; it must be effected by some local authority.

4081. It would be, would it not, for that Board to see that Local Boards and towns carried out the works, and prevented the streams from being poisoned?—Yes; and there are many Local Boards who would do their duty properly if they had the legal power to do it, and could work simultaneously with the other Boards connected with them.

4082. Do you mean that they would at present?—I believe they would, if they had power to intercept the sewage and remove it on to the sites where it could be applied.

4083. What powers do they require for doing it; do you mean powers for going through the lands of other persons?—I think that they would require such powers as a Parliamentary Committee gives to a railway company.

4084. Do you think that they ought to have compulsory powers to purchase that land?—It would be of very small use for the people of Birmingham to make 10 miles of sewage carriers, for instance, into the country, if every landowner or every farmer bordering upon said carriers point-blank declined to have anything to do with the sewage.

4085. Then you must give them powers to purchase land to utilise the sewage upon?—In some cases you would be obliged to do so.

4086. Would those be the only powers that would be requisite?—I do not know of any others.

4087. Then, in fact, the change in the law would be very slight, would it not?—Very slight.

4088. Would it do to make the Local Government Act apply to catchment basins instead of to towns?—You must have a machinery for working it. The Local Government Act at present can do certain things, and can use Parliamentary powers under certain conditions; for instance, a Local Board can effect works of a particular kind within its own area without applying to any external authority; but if it wants to acquire lands compulsorily, either for sewerage or for waterworks, or for street improvements, or for any analogous purpose, and if it cannot treat with the owners of property, it then gets Parliamentary powers through the Secretary of State for the Home Department (a "Provisional Order," which in effect is a Private Improvement Act), at a cost not exceeding some 5 *l.* or 7 *l.* That machinery is now in existence, and Parliament has passed one Bill this Session, and there is a second going through the House of Lords now for confirming certain Provisional Orders, which are, to the local authorities, Private Acts of Parliament.

4089. Mr. *Cowper.*] According to your experience which, in your opinion, is the best example of the successful disposal of the sewage of a town without the pollution of streams?—I think, so far as I know, that Croydon is at the present moment the best example we have.

4090. Do you consider that the sewage which is applied to land at Croydon is a profitable application?—It is so far profitable that the Local Board of Croydon lease the land at one rental, and let it to the tenant with the sewage at 1 *l.* per acre profit. I am told that chemical analysis proves that when this sewage passes from the land into the Wandle it is purer, or as pure, as the Wandle water is; I was informed by the local surveyor that it absolutely was something slightly purer.

4091. In that case the Local Board at Croydon do not themselves take any active part in the agriculture of the land to which the sewage is applied?—No. They were compelled by the lawsuit which they had to take means, after trying all the several kinds of disinfecting and subsiding processes, after spending large sums of money in trying to make solid manure of their sewage, and to purify their water and pass it away, to lease, I think, 300 acres of land; and they have arranged with a gentleman, Mr. Marriage, to take that land from them for a certain time, he giving them 1 *l.* per acre more than they themselves pay, upon condition that he has the uncontrolled use of the sewage.

4092. Then the lessee takes all the agricultural processes on his own responsibility?—He does; he has the sewage conveyed to him, and he applies it to the land, and takes off the produce.

4093. Is Croydon a fair instance as regards other towns as to the quantity of water which is mixed with the sewage of the town?—I daresay that in Croydon, from its subsoil being gravel and chalk, there is spring-water in excess, and therefore the difficulty in Croydon is greater than it would be in most towns, if water is an evil, that is, if you have more water than you want.

4094. Can you state whether Watford has been a successful instance of the application of sewage?—At Watford the application is by pumping, I only

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only know what Lord Essex stated in his evidence with regard to that; I understood him to say that he was satisfied with his results; but it is not such an example as Croydon. The whole of the sewage is not dealt with in Watford; they only take it when they care to take it.

4095. Is it not the case that in Manchester and many of the towns in Lancashire, the excrementitious matter is applied in a solid form to the land?—The Manchester Corporation, I think, spend between 18,000 *l.* and 20,000 *l.* per annum in emptying the middens and cesspools, and the loss upon the transaction is about 50 per cent. They have returned to them by the sale of this material about half what it costs them to execute the work, and I believe that Liverpool is in a similar condition.

4096. Is that matter, when applied to the land, useful for agricultural purposes?—I suppose it is, or it would not be taken. The Manchester matter goes down as far as Lincolnshire; it is the soil refuse, mixed with ashes, and a good deal of rubbish, but still for that which cost them 1 *l.* they get about 10 *s.*

4097. Then would your experience lead you to suppose that the application of sewage in a liquid form is far preferable to its application in a dry form?—I know of no case of any profitable results from the application of sewage in a dry form; but I know of several failures, such as the Leicester case, and other instances. There are several places where the solid matters are abstracted from the sewage and mixed with ashes, and there there is no income; but in some instances the towns just save themselves; that is to say, the labour expended is about met by the sale of this material to the adjoining farmers; they get from 1 *s.* 6 *d.* to 2 *s.* 6 *d.* per ton for the material.

4098. Supposing that a law were passed to prohibit the pollution of streams by town sewage, do you consider, from your knowledge and dealings with Local Boards in general, that such a law would be much resisted or evaded by Local Boards?—If you make a stringent law which would prevent towns from using the natural watercourses as outfalls for sewage, you would, in my opinion, throw back the sanitary question, and compel town authorities to retain the old and objectionable form of cesspools. And any such law would be defeated in one sense, because in Manchester and in the Lancashire towns, although you do not drain directly into the rivers, you find pollution to an enormous extent. The overflow from all these cesspools, after putrescence has set in, goes into the river; and I know of no law that can prevent that, because if you say, "You shall not drain directly into the stream," unless you annihilate the population, you cannot get rid of the nuisance that they cause there; at present the river gets it after it has done all the mischief it can do to the people, and when it is in a concentrated fermenting poisonous form, and is likely to do the greatest possible mischief. I have had now a tolerably wide experience as to the effect of town sewage; and I would wish to explain to the Committee that when the injurious effects of town sewage are spoken of in rivers, you may take my word for it that it is something similar to the effects in the Manchester rivers, and in the Thames here. The injury is the effect of a putrid mass of matter being poured out, and not the effect of fresh sewage daily and hourly delivered as it is produced. In the case of Carlisle, for instance, the town has been sewered some 10 years into the Eden. That is a fish-producing river, containing salmon and trout; and there has not only been no complaint of any injurious effect upon the fish, but, on the contrary, the quantity and the quality of the fish are increased and improved. But there every atom of the sewage passes from beneath the city of Carlisle within 10 hours of its production before fermentation has set in.

4099. Does it fall into a part of the river within the influence of the tide?—No; Carlisle is above the influence of the tide, and the Eden is a large river. But there is another case, which is Buxton; that is washed by that small trout stream, the Wye, that flows through it; the town has been sewered within these last three or four years, and the sewers pass into that small stream about half-a-mile below the town. I have heard of no complaint of fouling there, and certainly it has not killed their fish. I do not say that it is right to put it in there, but the sewage goes in fresh, before putrefaction has set in, and there is not that contamination and undoubted injury that you get from putrefaction.

4100. Do you think, from the present state of our knowledge upon the subject, that the great object should be to carry the sewage as rapidly as possible into the streams, where it will not be detained, but will pass clean away?—I do not wish to say that; I am only saying what the facts are; I think the best mode of dealing with sewage in all cases is to carry it rapidly on to the land.

4101. But unless the sewage can be rapidly and adequately placed on the land you think that considerable danger might arise from any prohibition that would stop the existing methods which the Local Boards have adopted?—The first element in this question, in my opinion, is human life; and if you are to set that down as having the greatest value, that will be the most important item in the problem. My experience is this, that if you compel the detention of the refuse of cesspools in the vicinity of human dwellings until putrescence has set in, you as certainly manufacture fevers as that two and two make four. All my experience goes to that; therefore whatever legislation takes place it ought to take into consideration that if you cripple the town population by any enactment and compel it to forego sanitary improvement, such as removing the soil matter before it can putrefy, you will so far do injury. But I think that the soil matter may be removed if facilities are given, and it may be utilised or it may be applied to the land: and as to whether it shall pay or whether it shall not pay, commercially, I do not think that that question ought to stop the application; for, as I have shown the Committee, if Manchester now pays 10,000 *l.* a year for retaining its cesspools (an abomination which raises its mortality up to 30 in the 1,000, in the face of London with 23 in the 1,000), it might reasonably be asked that facilities should be given, here and elsewhere, to take away that putrefying matter and do something else with it, at a cost (or proportionate cost) of 10,000 *l.* per annum.

4102. Can you state why such an example as Croydon has not been followed by other towns in similar circumstances?—There is a landowners' question involved in that. All towns are surrounded by owners of land; few persons would willingly

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willingly let a sewaged farm come near them; there is a prejudice against it, and I daresay any of us if we were owners of property would look very seriously upon a proposition that the whole refuse of a town should come upon our estate.

4103. Do you think that it is a well-founded objection if the sewage is applied in the same manner in which it is applied at Croydon?—I do not think it is, and all the evidence that we have taken goes to show that the complaints are not well founded. Take the case of the Edinburgh meadows; it is not established that those meadows, although the application has been very profuse and very rude, have added to the mortality of the vicinity, but there has been strong evidence to show that they have not.

4104. In the case of Edinburgh, is not that a mode of application that will not be adopted at present by any town that commenced works afresh?—In Edinburgh they have the sewage for nothing; they have it entirely their own way; it has been applied to some of those meadows above 200 years, and this fact has been very useful, as showing that land will continue to utilise it for a great length of time. Putrid town sewage has been applied at Edinburgh for above 200 years to the same portion of land, and from that down to the present time the same land has given off a beneficial crop, and it is not proved to have been prejudicial to the health of the district. But it is applied rudely, in large open carriers, in which the sewage is floated along; and it is in those open carriers, where putridity continues from the scum and sediment upon them, that you have the nuisance and the stench which has been referred to, and not from the irrigated area where the growing plants exist.

4105. Then we understand you to say that if Local Boards had compulsory powers of obtaining land to which the sewage could be applied, one of the great difficulties which have hitherto stood in their way would be removed?—I think that Local Boards have in some respects compulsory power if they choose to use it, but I hardly conceive it to be the province of a Local Board to set up an agricultural establishment, and excepting you do that you cannot get a profit out of it. At this moment I am part proprietor in a small estate at Worthing, and we are going to apply the sewage as it is applied at Croydon on some 42 acres; we have not yet commenced to do so, and there is a very instructive lesson there: for although I am the largest owner in the scheme, and have some reputation as an engineer, and have had some experience in works, I could not induce the other gentlemen to follow my advice, but they got a notion that earthenware pipes would carry the sewage under nine feet of pressure; the consequence is that through those 12-inch pipes, under 9 feet of pressure, not a gallon of sewage has gone on to the land; the scheme in this respect has failed, and we have had to substitute cast-iron pipes instead.

4106. You have stated one reason why the example of Croydon has not been more followed; have you any other reason to give?—I think that that case wants to be better understood; I think you want to have a few more profitable examples. We find that in this country, when you do show that there is a way, and that it is not a losing way, the scheme will be taken up; but there is still a difficulty. Extravagant values for sewage have been made, and large rentals asked or talked about. At Worthing, as I say, I think they act with wisdom; they do not charge anything for the sewage. If they had charged anything, there would have been no experiment; they give the sewage, and they lift it on to the land for the purpose of getting rid of it, and avoiding litigation from landowners: and myself and some nine other gentlemen have been willing to embark our money to buy 42 acres of land to put it on, and at all events it will pay 5 per cent.; and if it pays more we shall be all the better off.

4107. In the case of Croydon, the Local Board were set in operation by an injunction, were they not?—They were; it was a matter of salvation to them.

4108. Mr. *Ferrand.*] Some time after the Sheffield Reservoir burst, you were employed by the Government to survey the reservoirs in Lancashire and Yorkshire; have you any idea how many reservoirs there are in Lancashire and Yorkshire which have been rendered necessary by the pollution of the rivers?—I am not aware of any reservoirs having been made simply because the rivers have been polluted; they are generally made for another purpose.

4109. I understand you to state that it was necessary in Lancashire, to make reservoirs for the purpose of supplying the inhabitants with pure water higher up than where the rivers now are, which have been polluted by manufactures?—I did not use the word necessary in the same sense in which the Honourable Member gives it. I said that it was the fact that all the reservoirs were made above the point at which the water is abstracted for manufacturing purposes; or they are made for compensation purposes.

4110. Are you of opinion that those reservoirs would still have been made if there had been no pollution of the rivers?—Yes; I do not think that pollution had anything to do with their being made. It is for the town supply, and for trade purposes, that they have been made.

4111. Are you aware whether engine cinders and ashes bind together in the bottom of the rivers?—Yes, they do, and obstruct the bed of the river very much.

4112. They bind very rapidly, do they not?—They do.

4113. Do you know anything of the state of the canals at Bradford?—I saw it some years ago, but I could not speak definitely about it.

4114. When you saw it was it in a very polluted state?—It was very foul.

4115. Are you aware whether, in the summer months, passengers in railway carriages passing by are obliged to close the windows on account of the foul air?—I have no doubt they are.

4116. Does not a foul vapour rise and settle on the hillsides above the rivers in the manufacturing districts?—That I do not know.

4117. You have been asked as to the effects of cholera in different places; are you aware that on the banks of the Aire, between Leeds and Bradford, there was a great mortality from cholera, not so much upon the banks of the river as at a distance up the hillsides?—No; but I know this fact, that high land may be so situated with regard to the prevailing winds that the drift of the valley may put that comparatively high land in a much worse condition than any area of the same extent in the vale.

4118. Do you know that that is the case in Keighley; that Keighley is a very healthy town, although all the streams around are polluted, while the little villages on the hillsides are in a far more unhealthy state?—I do not know that fact; but I know, from personal examination and experience, that where you have a high rate of mortality, or where you have such a disease as cholera, I have failed to trace it to external causes so much as to causes arising within the four walls of the dwellings.

4119. Do you know that the farmers in Yorkshire fetch the solid manure many miles from the factory privies in barrels, convey it to their farms, mix it with the soil, and then apply it to the land?—I do not know that.

4120. If I told you of the sewage of 3,000 inhabitants being applied by nothing but the plough opening furrows in the fields, with very great profit, and without the slightest annoyance to people living close to them, you would not be surprised, would you?—Not at all.

4121. Have you heard of any disease being produced by the application of sewage to land, or of any illness having been caused?—No evidence that I could rely on has been brought to my notice.

4122. Dr. *Brady*.] You have stated that the health of the inhabitants living on the River Thames during the time of that terrible state of nuisance which you have referred to was very good, or that the nuisance did not seem to affect the constitution of the people; was that so?—There was no marked difference; that is to say, there was no mortality that could be attributable to that foul state of the river. I remember hearing it discussed at the Epidemiological Society; and the late Dr. M'William, who had charge of the Thames Police, if I recollect rightly, could not give us any case of mortality from that cause. He gave us some cases of retching, which were brought on by the stench, but there was no palpable increase of mortality.

4123. Mr. *Tite*.] Nor was there any epidemic?—There was no epidemic.

4124. Dr. *Brady*.] Are you not aware that men working on river-sides are in the habit of receiving larger wages, and hence that they can get a larger supply of animal food than farm labourers in the country can obtain?—I do not know that.

4125. Are you not aware that at that time there was a very considerable amount of labour going on on the River Thames?—I am not aware of that.

4126. Do you not suppose that if the men were well fed at that time, it would have a preventive effect on disease?—Yes; I believe that wholesome exercise and good feeding is a great preventive against disease.

4127. Are you not aware that that was one of the reasons which was given at the time, that it prevented disease?—No, I am not aware of that.

4128. How long have you been a member of the Royal Sewers Commission?—Since it commenced in 1857; I was one of the first Commissioners appointed.

4129. Have you paid very considerable attention to the state of the rivers in the different parts of the country?—Yes; I have inspected most of the Lancashire rivers, and some of the Yorkshire rivers.

4130. In your first report you state: "In times of heavy rain the quantity of sewage liquid which comes down at Craigentinny is so great, that it is found impossible to deal with it otherwise than by allowing some portion of it to escape into the sea; but with this exception, and that of the open ditches, it may be safely asserted that the method pursued at Edinburgh deals with sewage, considered as a thing to be got rid of, with great success?—That is so.

4131. Then in an agricultural point of view it is not a success?—Yes, it is.

4132. You state that there is a great success, and at the same time you say that in an agricultural point of view it is not a success; how do you reconcile the two propositions?—Because those meadows are let annually at from 5 *l.* to 40 *l.* per Scotch acre, and they produce four or five crops of Italian rye-grass per annum, and as much as 80 tons per Scotch acre of grass has been taken off per annum.

4133. But if they have to pay for the amount of sewage that passes over them, how then would it be a success?—If you have to pay anything like the value which I have heard put upon the sewage, the balance would be on the opposite side; and that is why I believe that if any company is induced to enter into the speculation of applying the sewage of London, and agree to pay the Metropolitan Board of Works any such sums as I have heard named, I think that I can predict, so far as my opinion goes, that they will be in the Bankruptcy List very shortly.

4134. You have paid some attention to the experiments which have been carried on at Rugby, have you not?—I think that Mr. Lawes is prepared to give evidence on that point.

4135. But have you not, as a Commissioner, paid any attention to those experiments?—I have been over the works, but the experiments are purely agricultural and chemical, and these are matters which Professor Way and Mr. Lawes have made their specialty; and since I have had so much other work to attend to, I have not interfered with those experiments.

4136. Is not your name attached to the second report as one of the Commissioners?—Yes; but I put my name to that report upon the faith of the experiments conducted by those two gentlemen.

4137. Have you seen the evidence which was given by Lord Essex before a Committee of this House, wherein he stated, in answer to Question 76: "There have been some very interesting experiments made under the superintendence of Mr. Lawes, at Rugby, in an agricultural point of view; but I do not think that they have been carried out in a manner to prove the full value of sewage, inasmuch as they have only been carried out upon meadow grass, and, as I suggested to Mr. Lawes at the last meeting of the Commission, that is not a fair trial of sewage, because if a certain quantity of sewage will give a certain quantity of meadow grass, I am convinced that the same quantity of it will give a double return of artificial grass"?—Mr. Lawes is conducting the experiments now, and I believe he will be able to give the Committee a clear reply to that question, and that he will give the Committee definite results and not speculative answers.

4138. But do you consider, with Lord Essex, that making experiments upon meadow grass was not a fair mode of trying the value of the sewage?—Although I am upon this Commission, I have never taken upon myself to judge as to experiments in an agricultural point of view. I suppose that I was put there from my engineering knowledge, but I do not profess to know anything of agriculture.

4139. Then,

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4139. Then, as an engineer, did you see that the lands were laid out in the best way by which the sewage could be applied?—I saw this, and I obtained this information, that the existing means of applying that sewage was most costly and extravagant, and was calculated to reduce very much any beneficial effect from the application of the sewage.

4140. Had it received any preparation under you?—No; it was under Mr. Walker, the owner of that estate; he extended his piping to a great many more acres than he had a sufficient amount of sewage to apply. I do not approve the method of passing sewage through small pipes and applying it by hose and jet; I do not think that you can make sewage pay by such an application.

4141. *Chairman.*] Is the hose and jet used at Rugby?—The hose and jet was used by Mr. Walker, but Mr. Lawes will be able to give the Committee information upon that subject. I think that he has not used it; he has open carriers.

4142. Dr. *Brady.*] If you disapprove of the hose-and-jet system, how, in your opinion, can sewage be applied equally over land that is in an uneven state?—There are several methods of doing it, one of which has been in practice at the great milk-farm near Glasgow, where the sewage is pumped into a tank at an elevation, and they have moveable pipes with spigot and faucet joints, which shed at the outer end, and pipe after pipe is drawn off, and the shedding is back; then they have another line, and again shed back upon the surface.

4143. *Chairman.*] Is that the same system as is adopted in the Champs Elysées at Paris?—It is.

4144. Dr. *Brady.*] Is any similar process adopted at Rugby?—I think Mr. Lawes will tell you they pass the sewage there by surface carriers. There is no land with which you could not deal in the same way; you could take a peculiar kind of plough, and just turn the sod up, having laid out your contour lines, and you could irrigate the surface by gravitation.

4145. Mr. *Ferrand.*] There is nothing to prevent the use of the plough for that purpose, is there?—Nothing whatever, unless there is some specialty in the land which I do not know of.

4146. Sir *Joseph Paxton.*] Did you not state that Croydon has been the most successful place where there has been any application of sewage?—I will not use the word "most"; I believe the application at Croydon to be successful.

4147. They have applied the sewage there to 300 acres, have they not?—They have power to apply it to 300 acres; they have a lease of about 300 acres.

4148. To how many acres do they apply it at present?—When I saw it two or three years ago they had only applied it to 30 acres; but I do not know to how many it is applied now.

4149. Do you know the number of inhabitants in Croydon?—I do not remember at this moment; but I know that at Worthing we have 42 acres of land, and we are going to put the sewage of about 7,000 people upon it; that will be upwards of 100 per acre.

4150. You have mentioned that at Birmingham they have deposit places where as many as 25,000 tons of sediment accumulated in a year; is that so?—Yes; but that is not sewage sediment. Birmingham, until recently, had all its roads and streets formed of macadam, and the great weight of that sediment was the mud and the material washed from the surface of the roads, and was not really sewage.

4151. In those places in Yorkshire where you saw the bridge very much filled up, might not that be the sediment also?—Yes, and the washing in of foundation materials and ashes, and all the refuse that is thrown in; for instance, a short time ago I was in Huddersfield, and there was a mill on one side of the river which had its cinder-tip right over to the opposite side; and there was another mill which also had its cinder-tip over to the opposite side, so that they were interlocking, and the first flood would take away 40 or 50 tons of cinders from there.

4152. Have you observed, in the case of these sluggish rivers in Yorkshire, that the river itself is very much above the surrounding district; how is that deposited?—The upland waters bring down sediment, leave it in the bed of the river, where the velocity is reduced below a certain flow per minute, and the river-bed is gradually raised until, in flood-time, it creates a swamp on either side of it.

4153. And that raises the sides, does it not?—Yes.

4154. Would that, to a certain extent, be the case through all those towns where the flow of the water is very much impeded by mills?—Mills and mill-dams have worked, I should say, more mischief than ever they have earned good within the last half-century. Mills and mill-dams raise the bed of the stream and waterlog the land; and I believe that, if it was fairly calculated, they are doing more injury than good.

4155. Is it your opinion, taking the Valley of the Thames, that it would not be a very great improvement if you were to take down a very large portion of the mills in that valley?—If you are to improve such places as Oxford and other towns, which are similarly situated, you must either have power to remove the weirs, or to have a waterway round them; you must have a channel to reduce the water round them, but certainly the best improvement is to remove the weir.

4156. You have had very great experience in observing those rivers, and you have mentioned Buxton and the drainage of Buxton; were you not called in in that case?—I devised and executed the sewerage at Buxton.

4157. After the sewage of Buxton passes into the River Wye, did you ever examine it at 10 or 15 miles down the river?—No, I have had no opportunity of examining it.

4158. Have you had any opportunity of seeing that it is as clear there as possible?—No, I have not. I have asked once or twice whether they have suffered any nuisance from it, because I hold that at Buxton they ought to put it on the land, even at some cost to themselves; but I believe that they have suffered no injury, and I know that it does not kill their fish.

4159. Sir *William Russell.*] Did I rightly understand you to state that you believed that the proper method of using the sewage on land was by simple gravitation and not by pumping?—The cheapest method is by gravitation; that is to say, where the conditions will allow, you will get most benefit by gravitating it upon the land; but if you have to resort to pumping, you can pump with advantage. But what I meant to say was that I would not subdistribute sewage by hose and jet.

4160. Is it not also the fact that by distribution by

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by gravitation you get the sewage more rapidly on the land, and that pumping it and collecting the water for a certain time is apt to produce that very stagnation and putrefaction which you are complaining of with reference to some other rivers; if you pump it you must have a certain reservoir, and in that reservoir does not a certain amount of putrefaction take place? — If you pumped the sewage you would have so to arrange your pumps as to take away the dry-weather flow; and there one of the difficulties, or rather a group of difficulties, comes in in dealing with sewage. Sewage is a constant quantity, that is to say, the flow is unceasing; it is variable in volume, but the flow is constant: and supposing the dry-weather sewage of a district to be 100 gallons per second, the wet-weather flow will be from 300 up to 500, and no arrangement, so far as I conceive, can be entered into to enable any district to deal with such excesses; you cannot deal with them in London, and you cannot deal with them in any district that I know. I mean to say that it is not practicable. If a small town is to utilise its sewage, that means, in my opinion, that it would utilise the sewage proper, the dry-weather sewage, but it would not attempt to utilise the rainfall in floods, because that would be impracticable.

4161. That could not be done even by gravitation, could it?—No. Floods must go away through the natural channels of the country.

4162. The sewage of how many persons did you state that you believed to be applicable to an acre of land?—I think that we shall try to get rid of, or to put on, the sewage of about 160 people per acre at Worthing; but if we can get 20 more acres of land I think it would be quite equivalent to irrigating about 60 acres from a population of about 7,000 people, and at that rate you would require for the Metropolis, instead of 1,000,000 acres, about 30,000 acres.

4163. Are you aware that at Croydon they apply the sewage of 60 people to one acre of land?—I do not exactly remember the proportion, but I daresay that it is about that.

4164. That is owing very much to the large quantity of water which they have to deal with, is it not?—Not so much that, as that they have this Chancery injunction over their heads. They are not to drain any of their effluent water into the Wandle so as to render the Wandle more impure than it is, and they would naturally be anxious to be on the safe side.

4165. But you do not think that would require so large an area of land as would be given by applying the sewage of only 60 people to an acre?—I think that, if the land is favourable, you may dispose of the sewage of from 100 to 150 people on an acre.

4166. With regard to compulsory powers for purchasing land, did I understand you to state that there is sufficient power at present for Local Boards to be able to obtain land for the purpose of utilising the sewage, or merely to enable them to obtain powers to pass through land with their drainage works?—The Local Government Act provides for certain definite things, but is restricted in its rating power. You can rate under the Local Government Act up to one year's rateable value for certain purposes, and you can rate up to two years' rateable value under other conditions; but if you were to attach to it the acquiring of land for the application of sewage that might be inoperative, because it might bring in an amount of expense which their rating powers would not enable them to meet.

4167. But does the existing law give Local Boards sufficient power to obtain lands for the purpose of utilising the sewage, or is it necessary to get a special Act to obtain compulsory powers? —I think that the machinery under the Local Government Act would enable a Local Board to acquire land for utilising the sewage if its rating powers are sufficient; a Local Board can have power, upon application to the Secretary of State, to get what is equivalent to a Private Act of Parliament, namely, a Provisional Order, which gives the necessary power quite as much as any Act of Parliament does, and I think a Local Board would be only limited by the amount of power to raise the necessary funds. The Secretary of State's Provisional Order does not give any additional power to raise money.

4168. Is it absolutely necessary, if the sewage is to be utilised, that there should be some such power, because there are certain lands upon which it cannot be utilised?—That is the case; in many instances you must bring into operation steam-power to pump sewage

4169. Mr. *Caird.*] Did you not state that the impurity of the rivers caused by sewage began in the year 1840?—The impurity of the rivers, of course, began with the commencement of population; the inhabitants living on the banks of the rivers have polluted them from the very first.

4170. But, in answer to a question which was put to you, you gave the date of 1840 as the date to which you specially referred?—Yes; about that time the introduction of waterclosets became general, and since 1850 they have been enormously increased. There were in many Local Improvement Acts of Parliament prohibitory clauses to prevent waterclosets from draining into sewers, and before that period, if you had a watercloset, it must drain into a cesspool; I do not know whether that law has been actually repealed as regards the Metropolis, but practically it is so, because all the sewers are used for that purpose. Such a prohibiting clause was in operation in Liverpool in 1843 or 1844, and I think that waterclosets were not allowed to use the sewers in Liverpool as late as 1845. The architect for St. George's Hall was obliged to construct cesspools for that building.

4171. Do you ascribe to the introduction of the watercloset system very injurious effects to the rivers?—I ascribe to that system the pollution of the rivers with excrementitious matter, certainly.

4172. Have you not also stated that the retention of the fœcal matter by cesspools was becoming very injurious in Lancashire?—It has always been very injurious, and is very injurious wherever it is practised.

4173. Does that arise from the fact of putrefaction taking place in the cesspools from their not being immediately cleared out?—It arises from the putrid matter fermenting and giving off a gas which is very injurious.

4174. Are you aware of the practice of deodorisation which has been introduced in the cesspools in some villages in the neighbourhood of Manchester?—I am aware of the existence of a company, called the Eureka Company, which has taken up that question at Ashton-under-Lyne, where by a disinfecting medium, and by an arrangement of boxes, which they place under the seat of a privy, they successfully disinfect the odour, and the solid refuse is taken away at intervals, and

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and manipulated for the purpose of being applied to the land.

4175. Is it removed weekly?—I do not know at what intervals it is removed; but daily or weekly, whatever the arrangement may be, it would be utterly inapplicable to the Metropolis.

4176. Are you aware whether that system has been found successful where it has been tried?—I am aware that it has been carried out to a certain extent in Lancashire, but I have not inspected the works, nor any of the houses where the apparatus is at work.

4177. In the case of Manchester, where, as you have stated, the authorities incur an expenditure of about 10,000 *l.* a-year to get rid of the solid fœcal matter, might such a system be profitably introduced?—No, I think not, for this reason: you are multiplying independent action, and you are setting up independent action over a large area. If you are to take London as an example (for if you run a thing into its extreme, you will see what it will bear), I suppose that there are upwards of 400,000 dwellings or tenements in London; and if you removed the fœcal matter from those houses once a week, you would have 400,000 operations weekly. I was speaking a short time ago to the promoter of this scheme, and he was very angry because I would not recommend a town to have a sanction under the Public Works Act for carrying out his system. I talked the matter over with him, and he said, "I grant you that we could not do it in London, because we should block up the traffic of the streets with our collecting-carts.

4178. Supposing that it is not applicable to the case of London, is it not possible that it may be applicable to smaller places?—Not so beneficially as the introduction of drains and water-closets even for small towns. Take, for instance, the town of Alnwick, in Northumberland; you have an entire population using water-closets more completely even than they do in the Metropolis.

4179. *Chairman.*] Are you aware of that from personal inspection?—I executed the works at Alnwick both for the town and for the Duke of Northumberland's residence; even beggars' lodging-houses and public schools have waterclosets in Alnwick; I do not think that you would find a cesspool in the place.

4180. Mr. *Caird.*] Would you say that because the whole fœcal matter of Alnwick is taken away by the water-closets, the sewage of Alnwick, if applied to the soil, would be of a good character for agricultural purposes?—I have no doubt at all about it. I think that you could find no richer sewage in England, because they have a minimum water-supply and a maximum closet supply. The amount of their water-supply is about 130,000 gallons a day.

4181. Do you know anything about the result of the application of sewage to the neighbourhood of Alnwick as tried under the Duke of Northumberland's orders?—I know that before the works were quite completed, and without the cognisance of the Duke, we got, through his agent, a portion of the land close under the castle walls, where we could distribute the sewage by gravitation, and for two or three months we irrigated some two or three dozen acres of that land and hurdled it off. It produced splendid crops; the sheep ate it with avidity, and it was acknowledged to be a success; but of course the Duke did not care to have sewage works immediately under his castle walls, and it was abolished.

4182. What was done with it then?—It went into the river about a mile below, and certain arrangements were made to pump it up from that point by a water-wheel. I also know that the farmers have discontinued using it, but I do not know all the ins and outs of the case.

4183. You do not know whether it has become mixed with the river water?—I am perfectly certain that it has not been diluted with river water in the sewers, and I am certain that whatever may be the cause of its not being applied to the land, it is not because it is not good sewage, or that it would not be good if it were applied to the land adjoining.

4184. You disapprove of the cesspool system, do you not, and also of a system of water-closets which should carry the whole of the fœcal matter into the river?—No.

4185. Did you not state that if water-closets were universally introduced, the streams would become worse than they are?—Yes; but I think that I subsequently stated that there are other elements in the question, and that I conceive that the first and prime element to be inquired into is the value of human life. If the introduction of water-closets reduces the mortality, as it has in the case of London, to 23 in 1,000, while you have a mortality in Liverpool, Manchester, Salford, and other large inland towns of from 30 to 31 in 1,000, and if it can be proved satisfactorily that by introducing water-closets, and fouling the streams worse than they are fouled now, you could save something like 50,000 or 60,000 lives per annum, that would put the balance in favour of the water-closets. In my opinion the saving of human life ought to outweigh every other consideration, even supposing that it were necessary to foul rivers.

4186. Have you any facts which lead you to the conclusion that the comparatively higher state of the health of the Metropolis, as compared with that of Manchester, is due to the water-closet system as compared to the system adopted at Manchester?—I believe that you would find, if a return were obtained from the Registrar General, that as you have done away with cesspools and substituted water-closets, you have gradually improved the health of the Metropolis.

4187. Then are the Committee to understand that, taking health as the primary consideration, the system of water-closets is the best system even for getting rid of the fœcal matter?—I believe so, from its immediately passing away, even if it fouls the rivers. I believe that the Paris system is a more expensive and far more injurious system; they have large sewers which take the overflow of their huge cesspools, which are in many cases as big as this room, 40 feet square and 12 or 15 deep, and they retain the water and slop refuse until it can do the greatest amount of mischief.

4188. In that way does the whole subsoil of Paris become sodden, as it were, with this fœcal matter in a state of putrefaction?—The Parisian authorities superintend the construction of those cesspools, and they profess to make them watertight, and to hermetically seal them; but we know that that is a fallacy, and that the gas blows through the joints, and that cesspools are not hermetically sealed.

4189. You have made some statements as to the gradual filling-up of the river-beds in Lancashire and Yorkshire by refuse continually being poured into those streams, and you stated that the consequence was that the bed of the rivers,

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rivers, in many cases, had been very much raised above their natural bed; has there never been any complaint on the part of the landowners and farmers occupying land on the course of those rivers at this great change of circumstances?—No doubt they complain when their land is flooded; but there I would wish to guard myself: I do not conceive that the filling up of those beds is entirely due to town sewerage.

4190. But do people at all those places without control put in their waste matter of every description, either clay or sand or anything else?—So far as my knowledge extends they do. There are complaints from owners of estates, but they are powerless; it is a thing which grows up so gradually, that it is only when you inquire back and ask the condition of things 20 years ago that you perceive it. I have seen a bridge that a dog could scarcely creep under, and I have been told by persons living, that they have driven a cart through that same place.

4191. With regard to the drainage at Croydon, and the manner in which the fæcal matter is got rid of, it would appear that at Manchester no great profit arises to the ratepayers from the agricultural value of the sewage?—At Croydon the Local Board obtain 1 *l.* per acre for 300 acres; at Manchester 10,000 *l.* a year is paid to remove the refuse of cesspits.

4192. But is it not necessary to expend something out of that 1 *l.* for the works and for the maintenance of the works?—I think not; I think that their sewerage is completed, and the person that rents the sewage, takes it at the outfall, where it is at sufficient elevation to gravitate.

4193. Still to complete the sewerage, must not some considerable expense have been incurred?—Yes, they have spent 40,000 *l.*

4194. Then, that 1 *l.* per acre of profit would be very inadequate interest on the 40,000 *l.*?—Yes; but in Manchester a proportionate sum has been spent on main sewers and cesspits.

4195. The result is, that to the ratepayers there is no money profit?—No; but at Croydon a rate of mortality of 25 in a thousand is reduced to 15 in the thousand. At Manchester the rate of mortality continues at from 29 to 31 in each 1000.

4196. Do you think that in a sanitary point of view; it has been of immense advantage, even though, in a pecuniary point of view, it has realised a very small advantage?—I think that if you could take the vote of the ratepayers, they would not go back to cesspools.

4197. Was not a considerable part of that outlay of 40,000 *l.* expended in different systems and attempts to utilize the sewage?—I daresay they have spent several thousands of pounds in making abortive tanks and attempting to solidify and to use portable manure.

4198. Sir *Joseph Paxton.*] What do you think it would cost to begin *de novo* there, and to take this sewage to those 300 acres of land?—Not more than some 24,000 *l.*, I venture to say, offhand, that I dare undertake that if there was not a sewer existing in Croydon, I would effectually sewer it for 1 *l.* per head of the population, provided I do not waste any money upon portable sewage manure experiments.

4199. Mr. *Caird.*] With regard to the valley of the Thames, some questions were put to you as to the re-pollution of drainage that falls into the valley of the Thames above tide-mark; have you ever examined the water superficially or otherwise to see the state of its purity or impurity?—I have seen it at Kingston occasionally, at the pumping works.

4200. Have you not found it to be in a comparatively pure state to the eye?—When you have a continuance of dry weather, it is so, but in a freshet, it comes down muddy, and, after very heavy rain, it comes down the colour of pea-soup.

4201. Is it apparently in the purest state when there is least water in the river?—It is apparently in the purest state when there is nothing to stir it up.

4202. The impurity is the impurity from drainage from the land and not from the sewage from towns in cases of flood?—Thames water is more impure when it looks the brightest than when it looks the muddiest; it is much more unfitted for drinking purposes in its bright state. If you take away the mud and filter it out, you have a better water than when the river water looks so bright and clear.

4203. Because no doubt it is in a state of greater dilution when the river is very full. The question of the wholesomeness of the water does not depend upon its being transparent but upon its being largely diluted; is that so?—That is so.

4204. Having regard to what you have said about the sewage of Carlisle flowing into the river Eden, and not only doing no damage to the river, but really seeming to increase and improve the fish, do you ascribe that fact to the sewage being carried rapidly away before it has time to ferment and putrify?—I do.

4205. Supposing that there were a sufficient volume of water in the Thames above tide-mark, would not the same result probably follow, that is to say, if the whole of the sewage of towns like Oxford and Reading, were carried rapidly into the Thames, and there were no obstruction in the course of the river, would not the same result follow, as in the case of the Eden, namely, that there would be no injury to anybody?—It would still be the sewage water, and the chemical ingredients of sewage would still be capable of being detected by the chemist; and then it becomes a medical question as to whether it would be injurious to the human system. I at present drink the Thames water with no injury to myself that I know of, but I would much rather drink water without such impurities.

4206. Are you not aware that there are great quantities of fish above tide-mark?—Yes.

4207. Have you ever bathed above tide-mark in the Thames?—No.

4208. You have given one answer with regard to the fact that landowners in the neighbourhood of towns, have a repugnance to allowing the sewage of any large population to be brought upon their land; does not that arise from the belief which is generally entertained that it would create a nuisance?—No doubt it does, just for the same reason as many landowners object to a cemetery.

4209. Would your experience lead you to say that no such nuisance need really be occasioned?—I am satisfied that if this room were a grass-plot, you might irrigate it every morning, and not have any perceptible smell from it, within half-an-hour after the irrigation.

4210. But if there were a perceptible smell for half-an-hour after, would not that be a nuisance that would justly be complained of?—It might be, but even that evanescent smell might be very cheaply got rid of by using a disinfectant.

4211. At what point in the system could you use a disinfectant?—Immediately before pumping. The sewage of Carlisle has been for four or

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or five years used upon the meadows which are bounded by the River Eden, and Mr. M'Dougall, who is the patentee of a disinfecting fluid, does use it before the sewage water goes on to the land, and I understand that there is no perceptible smell at all from it.

4212. Do you know whether there is much expense attending the use of that disinfecting fluid?—Not very much.

4213. Could the use of such a fluid be very easily and practically applied to the whole of the sewage of London?—I believe that he applied his disinfectant during that very hot summer, in 1859, to a portion of the district of London, and I think that the calculations as to the expense have shown us that you may use a disinfectant of that kind, varying from lime at 1 *l.* per 1,000,000 gallons up to perchloride of iron, at 3 *l.* per 1,000,000 gallons, and the effect would be completely to destroy the smell for a time, and if you applied the sewage to land at once, the effect would be effectually to destroy all smell.

4214. That is to say you would prevent any nuisance arising from application of the sewage to land, and the land will afterwards itself remove the possibility of any further complaint arising?—Just so.

4215. So that by means of two processes, a disinfecting fluid applied to the sewage, and the natural deoderizing action of the land, the application of sewage in such quantities as you speak of in the neighbourhood of London would not be injurious?—It would not be perceptible to the smell, and I believe that it would not be injurious. But that is a medical question.

4216. *Chairman.*] I wish to call your attention to Answer 3756, which was given by Mr. Dale. It is this:—"From my knowledge of Alnwick, I do not see how the sewage of the town could be worth anything, inasmuch as there are very few water-closets that run into it; there are principally cottages, tanks, and cesspools away from the houses, all of which are emptied, and the sewage carried away by nightmen, and the sewage of the town would be composed of the mere washings and surface water;" have you any remark to make with regard to that?—The gentleman who gave that answer knows absolutely nothing whatever about it; he does not know what Alnwick is, and he certainly is not speaking of the Alnwick of the last six or seven years; he is speaking of some Alnwick of 10 or 15 years ago; I carried out the works, and I know that Alnwick, of all the towns in England, is, perhaps, the most completely water-closetted.

4217. Do you speak from your own knowledge when you make that statement?—I speak from my own knowledge. As I said previously, the very beggars' common lodging-houses have water-closets or soil-pans.

4218. Mr. *Sclater-Booth.*] It has been stated before the Committee that the cesspool system was coming into fashion again; is that within your experience?—It is not within my experience, and I sincerely hope that it is not the case.

4219. You have spoken of the French system as being partially a cesspool system, and the cesspools in Paris being hermetically sealed, but is it not the fact, that however hermetically they are sealed, there must be an entrance from the cesspools into the houses, and that by that means the gases may escape back into the houses?—I have no doubt, and from experience in my residences in Paris, I can detect the cesspool gas almost instantly.

4220. Is it not the fact that a cesspool is more innocuous when it is open than when it is hermetically sealed, provided that you put charcoal over the covers?—The most dangerous condition of a cesspool is for it to be covered; if you are to have cesspools the safest plan is to take the top off, and to let the gas be continually diluting.

4221. At Winchester, was not an operation of that kind very successfully carried into effect under your recommendation?—The medical men tell me that they have had much less disease in the hospital since that cesspool cover was taken away.

4222. Will you describe the process which takes place there?—There was a large cesspool, into which the sewage of the hospital passed; there was no means of sewering the hospital, there is no sewerage in Winchester, the overflow went into the subsoil and into an adjoining stream. The only remedy that I could recommend was to remove the top of the cesspool off, to build a wall round, and to cover it with a grating of wire and iron, to lay 12 or 14 inches of charcoal, the size of horse beans, to break the continuation of the sewers in connexion with the hospital, and to put little charcoal ventilators, so as to prevent any gas from passing back again into the hospital. That has been at work for some time, and the medical men inform me that erysipelas had diminished very much after that, though they had a very serious outbreak of that complaint previously and during the time the cesspool was being emptied.

4223. Mr. *Tite.*] Did I rightly understand you to state that you thought that the cholera was more due to causes within the four walls of the house than to anything external?—That is my experience from all the inspections which I have made.

4224. Did you state also that the fouling of streams and wells, as was suggested in the case of Broad-street, St. Giles's, did not tend so much to increase the disease as the system of cesspools?—The evidence as to foul river water is strong to show that that is not the cause of excessive disease. Tainted drinking water has been proved to cause disease.

4225. What causes do you allude to within the house?—Supposing that you have foul drains within the house; that is a cause. Take the case of Edinburgh which believes that it is sewered; there is the most complex apparatus for conducting all the gases into the houses that you can have.

4226. Mr. *Caird.*] That is an error, I suppose; they do not mean to do that, do they?—They do not mean to do it, but they practically do it, because the street sewers are connected with the house drains, and the house drains are connected by direct communication with the water-closets. Most of the hotels that I have been in, in Scotland, have their water-closets not upon the external wall but upon an internal corridor, and there you have arrangements for bringing back gases of the sewers directly into the houses.

4227. Mr. *Tite.*] Did I understand you to say that you thought those impressions which exist of the great value of the sewage of London were erroneous?—I do think so.

4228. Do you mean that they are erroneous in an economical point of view?—I think that any attempt to extract a large rental from persons to use the sewage of London will fail.

4229. Therefore, you imagine that to raise a large sum of money amounting to 4,000,000 *l.* or 5,000,000 *l.*

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5,000,000 *l.* for the purpose of attempting to utilize the sewage of London never could bring back any return consistent with that large outlay?—Certainly not, in my opinion.

4230. Are you acquainted with the schemes which have been proposed to the Metropolitan Board of Works for the utilization of the sewage of London?—I have barely glanced over them; I cannot say that I am acquainted with the nature of them.

4231. You used the very distinct and strong phrase that a man who attempted to expend much money for the utilization of the sewage of the Metropolis would very soon become a bankrupt; do you abide by that opinion?—I abide by that opinion, and I think it would throw the question of beneficial utilization back as failures previously have thrown it back.

4232. Were not those former experiments to deodorize the sewage?—To deodorize sewage, and make a portable manure to rival guano.

4233. Were there any experiments made to utilize the sewage in a liquid state which have failed?—I think you cannot state that the Rugby experiment has failed. Mr. Walker might have had three-fourths of his money in his pocket and have brought more land within the influence of the sewage at less cost.

4234. Has he had to erect expensive machinery?—There is the piping over a much larger area than he has sewage for.

4235. I think you stated that you trusted to what Mr. Lawes told you about those experiments?—Just so.

4236. Dr. *Brady.*] Upon what grounds do you form the opinion that sewage cannot be applied in a liquid state to the earth, even to produce a large amount of income; what practical knowledge have you to justify that opinion either as a farmer or as an engineer?—If I had to do with the sewage of London, I should try to get it on to an area of 30,000 acres; if I tried to put it over four times that area, the cost would not be four times as great, but in all probability it would be as the square of the area; that is to say, 16 times as great both for distributing it, and for managing it.

4237. You have stated that Mr. Walker failed because he had not sewage enough for his outlay?—I meant to say that Mr. Walker had carried his pipeage to a larger area than he could find sewage for.

4238. But if he had sufficient sewage for the area of the land through which he laid the pipes, would it not then be a very profitable affair?—I think that his mode of laying down his pipes is objectionable.

4239. But supposing that Mr. Walker did lay down his pipes in the proper mode, and had a sufficient quantity of sewage, would it not then have been profitable?—Then it would as a matter of course, if you had a profitable income from 30 acres, and if you had all the means ready to your hands for supplying 300 acres.

4240. I think you stated that great mistakes were made at Croydon in the first outlay?—That is so. The disinfecting tanks, and all the tanks for taking the solids out of the sewage failed.

4241. Then the expense for the Croydon works has been very much greater than it ought to have been, has it not?—By that amount, by all the money that they have wasted in futile arrangements, it has been greater.

4242. Have you visited those works lately?—I was there either last May or the May before; but certainly I have been there since they have had their growing crops. I have seen growing crops on the ground.

4243. With regard to Alnwick, you say that the farmers are not much encouraged in their attempts to use the sewage there?—I really do not know the merits of the case. I know simply that it is as rich a sewage as any in England.

4244. Do you believe that the farmers would use it if they had an opportunity?—I do not know.

4245. Did you not state that it was conveyed away from them?—I laid out the sewerage of Alnwick; the main sewer goes through the Duke's property into the river immediately below the castle by old square drains. The duke gave me every facility for sewering Alnwick; he allowed the main outlet sewer to be taken through his property. I took it through his ornamental grounds a mile below, and it ended there at the river. I have had nothing to do with it since, but, I believe, there have been some attempts to apply it to some land. The operations, I understand, have ceased, but I do not know under what conditions.

4246. Mr. *Tite.*] You have given your opinion very distinctly that you think 30,000 acres would be about the proper quantity of land upon which to apply the sewage of London; is that opinion based upon the deduction that it wants the sewage of 100 persons per acre?—In the operations of Mr. Lawes, I find that he has been disposing of the excreta of upwards of 100 persons at Rugby per acre, and that he himself, from his experience, if I understand him rightly, thinks that you cannot profitably deal with the sewage unless you have it in a concentrated form.

4247. Your calculation of 30,000 acres then is derived from 3,000,000 of population; that is the hypothesis, is it not?—Just so.

4248. Do you imagine that if it is not concentrated, ordinary sewage water as it flows into your tanks would still have to be dealt with in some way for some practical result?—Yes, I think so?—I know that common water without sewage is beneficial.

4249. Dr. *Brady.*] But you have no practical knowledge of yourself of this matter, have you?—No.

4250. Are you aware that Mr. Way states that five minutes after the use of the sewage on land it is perfectly without a particle of smell?—It depends upon the land, but I believe it is practically so. If you had a sandy subsoil, I do not think you would have any smell at all.

4251. Mr. *Caird.*] Do you not give the preference to open cuts for the distribution of sewage?—Surface cuts.

4252. You have stated that a nuisance would sometimes arise from the putrefaction of the matter in the drains?—No; it is the great open permanent carriers in Edinburgh, which are 100 years old, and which have the accumulated refuse of years, which are offensive.

4253. Could not some plan be adopted by which that cause of nuisance could be removed?—I have no doubt about it.

4254. There is nothing on that account to prevent the system from being carried out, that could not be easily remedied, is there?—Nothing.

Lunæ, 20° *die Junii*, 1864.

MEMBERS PRESENT:

Mr. Sclater-Booth.
Mr. Bright.
Mr. Caird.
Lord Fermoy.
Mr. Ferrand.
Mr. Leader.
Lord Robert Montagu.
Mr. North.
Sir Joseph Paxton.
Mr. Tite.

LORD ROBERT MONTAGU IN THE CHAIR.

Mr. JOHN CRAVEN, called in; and Examined as follows:

Mr. *J. Craven.* 20 June 1864.

4255. Mr. *Ferrand.*] YOU reside at Keighley, in Yorkshire, do you not?—Yes, I do.

4256. Have you been engaged in trade there, together with your father?—I have.

4257. Are you acquainted with the state of the Keighley Beck?—I am.

4258. That beck runs through a considerable portion of the town, does it not?—Yes, through the main portion of it. We have two becks in Keighley, or, at least, two are joined together; there is what we call the North Beck, and the River Worth.

4259. In former days, did not the drainage of the town run into this beck, and was not it carried off to the River Aire, in the valley below?—Yes; that is the way in which the town is drained, the River Worth flows into the Aire.

4260. Since Keighley became a manufacturing town, has it not been the custom for many people to empty engine ashes, and every other kind of refuse connected with their trade, into the River Worth?—Yes, it has been the custom.

4261. Within your knowledge, has the bed of the Worth been raised by this custom?—Very much so indeed.

4262. Are you aware whether the ancient drains of the town have been buried, and covered over with this filth?—Some of them are already stopped up, and the drainage all dams back into the cellars, and we cannot get it away at all; there being no other outlet than the River Worth, which is being rapidly filled up.

4263. Have they no other outlet for some of the sewage of the town?—No other outlet whatever; they have not sufficient fall to take it anywhere else from some portions of the town.

4264. Have there been frequent complaints made, since the Local Board of Health was appointed, to that Board to induce them to take any steps to remove this grievance?—I believe it has been suggested many times, but they seem to take no notice whatever of the complaints; in fact, Mr. Waterworth and myself met a portion of the Board of Health about last January, or the beginning of February, and we took their Act of Parliament, as well as an opinion which we had got from Mr. Robert Hall, showing that they could prevent this refuse being thrown into the stream; they proposed to lay it before the General Board, and to let us know the decision; but we have never heard a word about it since, and they have declined to take any steps whatever in the matter. It so happens that we are so dissatisfied with the filling up of the stream, that we are about commencing an action ourselves, to stop this matter, and those plans which I have before me have been drawn for that purpose.

4265. *Chairman.*] Whom do you mean by "yourselves"?—My brothers and myself, constituting our firm; we have water-wheels upon this stream, and the throwing in of this refuse is destroying our water power, which is equal to engine power.

4266. Mr. *Ferrand.*] Are there any other gentlemen at Keighley engaged in trade, who have been injured by this system, as well as yourselves?—A great many of the individuals comprising the Local Board of Health are interested in filling up the stream in this way, because they have their works upon the stream, and it suits their purpose to throw all their dross, and everything of that kind, into the stream, by means of which they fill up the stream, and prevent the water from flowing in its proper course, collecting all sorts of filth, and the consequence is, that there is a very offensive stench in the town, especially during the hot weather.

4267. Is it, sometimes, a very serious evil at Keighley?—Very serious, indeed.

4268. Is it injurious to the health of the town?—Decidedly so.

4269. And does the Local Board of Health either refuse or neglect to take any steps whatever to put a stop to this nuisance?—They both refuse and neglect; we have laid the matter before them so many times that we are perfectly tired of taking any further steps in it.

4270. Have you any idea to what height the refuse has accumulated which has been put in the Worth?—I should think that above the low bridge, it has risen at least 4 to 5 feet within the last 15 years.

4271. When there is a heavy flood, what occurs?—The cottages are flooded.

4272. As well as the land in the neighbourhood?—There is not much land in that neighbourhood except what is built upon; it does not affect the River Aire.

4273. Is it the opinion of the medical men in the town of Keighley, that this state of things is very injurious to the health of the inhabitants?—That is the general opinion that I have heard expressed by the medical men.

4274. Sir *Joseph Paxton.*] Are not the floods very rapid down there sometimes?—Yes, they come very quick.

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4275. It is a sort of gully, is it not, going up towards Haworth?—Yes, one beck comes from Haworth, and this North Beck comes from a reservoir that was made by the Earl of Burlington, now the Duke of Devonshire, some 30 or 40 years ago. This North Beck is more filled up than the River Worth, but the River Worth is filled up down to Low Bridge.

4276. If materials were put in of a light character, they would go away with the stream, would they not?—Yes, if materials of a light character were put in, they would go away.

4277. But are they so heavy that they stop the flow of the water even at flood times?—Yes; we have large foundries upon this stream, and they have been placed there for the purpose of emptying their refuse into the stream.

4278. Is there no authority for preventing their doing that?—It has never been prevented; in fact, one firm in our town bought a small portion of land, about double the size of this Committee room, for the very purpose of emptying their refuse into the North Beck, and this North Beck is at one point within two yards of being filled up entirely.

4279. How many manufacturers put their refuse into the stream in the way that you have described?—I believe they nearly all do, except ourselves; we have not done it for the last 15 years. I do not know why they should do it, we have never had the slightest trouble with our ashes, &c.; people come and lead them away.

4280. What are their ashes made of?—Coals.

4281. Are they the same coals as yours?—Yes, but the foundry dross would be made from the smelting of iron.

4282. What do the ratepayers of the town say to this?—I have not heard many opinions expressed about the matter; people are dissatisfied at the becks being filled up; in fact, in a few years we shall have no rivers at all.

4283. Do those gentlemen who let their materials go into the water, themselves constitute the Local Board of Health?—Many of them.

4284. Are the majority of the Board gentlemen who act in this way?—I will not say the majority, but it is the interest of many of them to keep matters as they at present stand.

4285. Is there not sufficient influence in the town to cause this refuse to be removed?—That is the very point that we are going to try, individually.

4286. *Chairman.*] Did you state that this stream was injurious to health?—The more rubbish there is in the river, the more it decomposes and prevents the sewage being carried away freely.

4287. Is the sewage drained into these streams?—Yes; many of the drains are already stopped up.

4288. And it is that which renders it unhealthy, is it?—I should say so.

4289. How is it that the Local Board of Health refuses to take notice of this matter?—We cannot tell; only that many of them are interested in the silting up of the stream, and do not care about it; and they use their influence to prevent its being put a stop to.

4290. You think that there ought to be some authority to put the Board in motion, and make them observe the law?—Yes, we think so.

4291. And also to put the law in motion against any individual who puts refuse into the stream?—Yes; we are obliged to do it individually at present.

4292. And that involves you in expensive litigation, does it not?—Not only that, but the mill-owners, and a great many of the foundry people up the river, have entered into a sort of agreement, or rather a bond, that each will bear a portion of the expenses of any litigation that may arise upon the matter, so that whoever has to fight them, fights at a great disadvantage.

4293. So that, in fact, it is absolutely necessary that there should be some superior authority who should put this Local Board in motion; is that your opinion?—We should be very glad to have one. There is one very important drain which carries the sewage away from one densely populated part of Keighley, and which is entirely stopped up, on account of the river being filled up by this refuse; and when we laid our complaints before the Board of Health, we offered, if they would take this matter up, and commence an action against the parties, to make a sluice in our dam stones, and if we did that, we should be at an expense of several hundred pounds. It would, to a certain extent, clear the rubbish away from the mouth of that drain, but even with that inducement, they have declined to have anything to do with the matter.

4294. Mr. *Leader.*] Do you know of any towns which are similarly circumstanced to Keighley in your district, by having the drains stopped up by refuse being thrown in?—Burnley was in the same position, but the local authorities took it up and prevented it, or else it was nearly as bad at one time. They had a similar Board of Health to what we had, but within the last few years I think they have put a stop to anything being thrown into the stream there.

Mr. JOHN BENNET LAWES, called in; and Examined as follows:

Mr.
J. B. Lawes.

4295. *Chairman.*] You have been for sometime engaged in making artificial manure, have you not?—Yes.

4296. Did you not receive a testimonial for having so largely increased the supply of manure to the country?—Yes.

4297. From whom did you receive that testimonial?—From the public generally.

4298. Mr. *Caird.*] Was it solely for increasing the supply of manure, or was it not also in consideration of your services to agriculture as a chemical authority?—I believe it was solely for investigations connected with agriculture.

4299. *Chairman.*] You are a member of the Sewage Commission that was appointed in 1857, are you not?—I have been a member of that Commission since its commencement.

4300. Is that Commission still in existence?—Yes.

4301. You have presented two reports, have you not?—Yes.

4302. Do you contemplate reporting again?—We are now preparing another report.

4303. The second report contains a sub-report from you upon the experiments that you carried on at Rugby, does it not?—Yes.

4304. Have you received any remuneration for those experiments?—None at all.

4305. Has

Mr. *J. B. Lawes.*

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4305. Has Dr. Gilbert, who assisted you, received any remuneration?—Only from myself.

4306. Were there not other gentlemen from your office, Messrs. Christy and Gifkins, who also assisted you in carrying on those experiments?—All the calculations were done in my office, and all the superintendence was done by Dr. Gilbert, but that is not connected with the Government cost at all.

4307. Were none of those persons who assisted in carrying on those experiments remunerated?—The only charge made to Government was on account of the labour at Rugby, the payment for the sewage, and the rent of the land.

4308. Have you concluded those experiments altogether?—Yes.

4309. Do you consider that those experiments correctly show the amount of produce which could be raised by the application of a given quantity of sewage?—As far as they go, I think they do. There are certain lands, of course, where a better result would be obtained, and some on which a worse result would be obtained.

4310. Will you explain what you mean by the expression "as far as they go?"—They give a good indication of certain results obtained upon a certain class of soil.

4311. Lord Essex is Chairman of the Commission, is he not?—Yes.

4312. Are you aware that Lord Essex has stated that those experiments were not carried out in a way to show the full value of the sewage; and that if they had been fairly tried with other grasses the return would have been at least double; do you agree with him in that statement?—Not at all.

4313. Do you think that he is incorrect in his statement?—We have conducted some other experiments since upon other grasses, which have satisfied me that he is incorrect.

4314. Mr. Walker is the owner of that land, is he not?—Yes.

4315. He was examined before this Committee the other day, and he stated that those experiments were delusive and apt to mislead the public; do you consider that his statement was correct?—I am sure that they do not mislead the public.

4316. Would you think that the experiments themselves (I do not mean your report) would mislead the public?—I think, if they are looked at in their proper light they would confer immense benefit on the public; they are the most careful experiments which have ever been conducted; we have very carefully gauged and analysed the sewage for the last 2½ years, and therefore we know something about sewage, which nobody ever did before.

4317. Did you not predetermine the amount of sewage which should be used upon a certain extent of ground?—Yes.

4318. Was it applied in the months of May and June?—It was applied in each month in the year.

4319. Mr. Walker stated that the ground was absolutely drowned at one time, and parched at another time; is that correct?—It is quite correct in this way, that we have a great deal more rain at one time than at another. If we apply sewage where there is a heavy rain, of course the land would be saturated with sewage, and when there is no rainfall, of course it would be parched; we applied the sewage at stated times and in stated quantities, whether it rained or whether it was dry.

4320. Mr. Walker stated also that the grass was allowed to lodge, until it was cut at a stated time, and the roots were quite white, having commenced to rot, in fact; and that they were then left exposed to the sun, until they were baked, is that correct?—It is true to a certain extent. It is almost impossible to cut the grass exactly at one time, unless you have a very large dairy, so as to use it all.

4321. So that, to that extent at least, if the sewage had been more wisely applied, and the grass more often cut, the returns might have been greater?—I think they might, or you might get more profitable grass.

4322. Mr. Walker stated that by those means all the finer and better grasses had been killed off, and that nothing was left but rank coarse grass; is that the case?—No doubt; if you stop application of sewage on land which has been sewaged it will injure the quantity of grass. Wherever you try to grow a very large quantity of grass, the stronger grasses will overpower the finer grasses. We have stopped the application of the sewage altogether now, and we are closing the experiments to try what remains in the soil of the sewage by taking all the crops out.

4323. But before you discontinued those experiments, had not the finer grasses become very much killed off?—After you have put on sewage for a certain number of years, you change the quality of the grass altogether. In the case of the Edinburgh Meadows, a great quantity of grass is twitch, which is generally a worthless weed, but is a very good grass when you use sewage; the character of the herbage will be changed, it will be bad so long as you have it in hay or pasturage without sewage, but with sewage it would be very good.

4324. If a person bore those facts in mind, he would not be deceived by those experiments, but if he did not bear them in mind, he might be deceived?—If he interprets them fairly, I do not think there will be any doubt about the results.

4325. But, at the same time, might you not have obtained greater returns by a different application of the sewage; that is to say, by applying it oftener, and in smaller quantities?—It is quite probable.

4326. Mr. Walker states that his land has been permanently injured to the extent of 20 *l.* an acre in intrinsic value; do you consider that that is correct?—No, certainly not.

4327. Do you not state in your report that sewage grass is not good for fattening oxen?—Alone it is not; if mown, and carried into a stall.

4328. How is it that Lord Essex states that he has fattened bullocks with great success on sewaged grass alone?—I am not sure that he does not refer to Italian rye grass upon arable land.

4329. Then you could fatten bullocks upon Italian rye grass grown by sewage without other food?—With other food you could, certainly.

4330. But could you without other food?—I should think it is probable that you could; but they would fatten very slowly.

4331. It was stated before the Committee of 1862 that Mr. Beaumont, of Lochend, near Edinburgh, did the same; was that also with Italian rye grass grown by sewage?—I do not recollect his experiments; but it is quite possible.

4332. He might have fattened his cattle on grass which had been grown by sewage without other food?—Yes.

4333. With

Mr. *J. B. Lawes.*

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4333. With regard to milk, you state that for 1,000 tons of sewage the value of the increase of milk is 5 *l.* 19 *s.* 10 *d.*?—That is, I think, the gross money value upon the consumption of 1,000 tons of sewage.

4334. Does 1,000 tons of sewage give that return in milk?—That is the gross money value, allowing milk to be 8 *d.* a gallon.

4335. That shows a value of $1\frac{3}{4}$ *d.* per ton for the sewage, does it not?—Yes.

4336. Lord Essex states that if the sewage had been applied to Italian rye grass he would have got double the return; is that the case?—I think he does not state that 1,000 tons of sewage would produce double the quantity.

4337. At Question 76 he is asked, "In the Commission over which your Lordship presided, I think that you threw aside the question to a certain extent of the utilisation of the sewage, and went more into the method of getting rid of it." And Lord Essex says, "Yes, in a sanitary point of view," and speaking of your experiments he says, "I do not think that they have been carried out in a manner to prove the full value of sewage, inasmuch as they have only been carried out upon meadow grass, and as I suggested to Mr. Lawes at the last meeting of the Commission, that is not a fair trial of sewage, because if a certain quantity of sewage will give a certain quantity of meadow grass, I am quite convinced that the same quantity of it will give double return of artificial grass"; is that statement correct?—Since Lord Essex suggested that, we have put sewage upon rye grass, as well as upon material grass. We put upon one acre 787 tons, upon another, 1,523 tons; and if that is reduced to the produce per 1,000 tons of sewage, we get from one field of meadow grass 5 tons 15 cwt. for each 1,000 tons, and on the other, 5 tons 14 cwt. The rye grass gives the lowest quantity; 5 tons, and 5 tons 9 cwt., so that the increase is about the same in those particular experiments.

4338. Then your results were nearly the same?—Yes, but I must qualify this by saying, that in the rye grass experiment the land was in a good condition, therefore the sewage would not influence the crops so much.

4339. In fact the return from the sewage would have been greater if the land had been in a worse condition?—Exactly.

4340. Are those the gross returns that you have given?—No, those are the calculated returns to 1,000 tons of sewage supplied; you cannot compare 787 tons of sewage to 3,000 tons unless you make a calculation.

4341. But is that the gross return which you have got from the land, or is it the excess that you would have got?—That is the gross produce per acre obtained by each 1,000 tons of sewage over and above the unmatured produce; but you cannot very easily compare that with the 3,000 tons of sewage, and say, If so much sewage gives so much grass, how much will 1,000 tons give.

4342. Mr. *Caird.*] What we want to understand is whether the five tons of produce gained by the sewage from the meadow and from the rye grass is the surplus return above its natural produce?—Yes, it is the surplus.

4343. It is what you calculate to be the effect of the application of sewage, independent of the natural condition of the ground?—Deducting the produce in the natural condition of the soil.

4344. *Chairman.*] You apply sewage by the open channel or gutter system, do you not?—Yes; I apply the sewage by the gutter system.

4345. Do you consider that as good as the hose and jet?—I think it is more economical.

4346. Is it more economical with regard to the works that you would require?—I think it is more economical with regard to the very low value of the sewage in weight.

4347. Do you think that the returns would be as great as with an application by hose jet?—Not if they could be applied at the same cost.

4348. If you applied the sewage with the hose and jet, would the returns be greater?—I think that you would distribute it more evenly over the ground, unless you used an enormous quantity, so that you could flood the ground.

4349. Mr. Blackburn, before the Committee in 1862, stated that the returns by the hose and jet system of application would be three or four times as great as those from gutter irrigation; do you think that that is correct?—They would be nothing like that.

4350. Mr. *Tite.*] How much would they be?—I do not like to give an opinion upon that.

4351. *Chairman.*] Were the crops under your mode of application extraordinarily great in comparison to the crops that would have been grown without the sewage?—I will give the average produce of three years in two fields, one of which is manured and the other unmanured. The unmanured land produced 9 tons of green grass per acre; with 3,000 tons of sewage, it gave 22 tons; with 6,000 tons of sewage, 30 tons; and with 9,000 tons of sewage 32 tons.

4352. You did not try a smaller amount than 3,000 tons?—No.

4353. In how many dressings did you apply that quantity of sewage?—It was applied regularly throughout the year.

4354. Was it applied in 12 dressings?—A great many more than that.

4355. Could you state in how many dressings you applied it?—I cannot tell how many times.

4356. About 30 dressings?—I should think more than that.

4357. Should I be far wrong if I said 50 dressings or 60 dressings; do you think there were as many as 60 dressings?—I think there were not so many as that in each field, but it depended a good deal upon when we could get the sewage.

4358. Then you would put on more at one time than at another?—We should put on more at one time than at another, but we endeavoured to arrange it so as that each month should have its proper supply of sewage.

4359. Lord Essex states that he obtained "extraordinary crops, such as he never saw before using sewage," only using 600 tons to the acre; do you think that you might have got as great crops from an application of less than 3,000 tons?—I am quite sure we should not.

4360. You did not try?—No.

4361. Professor Way states that the sewage permanently improves the land, and that the good effects of it may be seen many years afterwards; but he says that the power of the earth to extract the manurial properties from sewage water are limited. Do you agree with him in that?—Yes.

4362. So, that if you exceed that limit, all the sewage that you use above that limit is wasted?—Yes.

4363. Would it run away into the drains?—Yes.

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4364. Would you see that it was being wasted by the water that ran through the drains being discoloured?—We have carefully analysed a great deal of drainage water, and we find that there is a large amount of sewage matter in the water that runs away, and that in the water from the field that slopes the most, contains the most sewage.

4365. If you put on a small dressing, would there be less of that matter in the liquid that runs away?—Proportionably so, no doubt.

4366. It is matter in suspension that colours the sewage water, is it not?—Yes; that is almost all retained in the soil.

4367. But if the water that runs away is coloured, does it not prove that it still retains some of that suspended matter?—Yes, no doubt.

4368. The chief manurial properties of sewage water are in solution, are they not?—Yes.

4369. But if the water that runs away contains matter in suspension, it is still more certain to contain what is in solution?—No doubt.

4370. Then if you see that the water in the drains is coloured, you may be sure it is carrying away a good deal of the manurial property of the sewage, and you may be sure that the limited power of the earth to extract those properties from the sewage has already been exceeded?—No doubt.

4371. Lord Essex, Dr. Angus Smith, and other witnesses have stated, that the effect of a given quantity of manure is more than doubled by its being liquefied; do you agree with that?—No.

4372. Do you think that a dry, solid manure would manure the land as well as if it were liquefied?—Within certain limits, I have no doubt of it, if you do not try to get too large crops. I do not think that a dry manure would produce 30 or 40 tons of grass per acre, but, within certain limits, if there is plenty of rain, I think it will produce very satisfactory results.

4373. You stated that, with dry manure, you were never able to get more than 12 tons of grass per acre?—That is the highest quantity that I ever got.

4374. But with the application of sewage, you have stated that you get 32 tons of grass per acre?—Yes.

4375. Then, it appears, that the liquid sewage is more effective than a dry manure, is it not?—Yes, when you come to large crops.

4376. If sewage becomes more extensively used, would it reduce the price of artificial manures?—Very little artificial manure is used in the neighbourhood of great towns, because the supplies of dung are so large; the use of artificial manures is confined to distant places where there are light soils, such as the counties of Norfolk and Suffolk.

4377. Within what radius of a large town like London would the farmyard dung be carried?—Perhaps 25 miles.

4378. It is carried by carts, is it not?—It is not carried so far as that by carts, it is carried by railway as far as that; I should think that 11 or 12 miles is the extreme carting distance. They bring in hay to London, and take back dung in the return carts; beyond that distance it is conveyed by railway; but the use of dung is confined very closely to the line of rails, because it is too expensive to cart it more than a mile or two from the railway.

4379. In the case of artificial manure, if you were to heap it up, and put it in too great an amount on the soil, it would not teach you anything about its fertilizing properties?—If you apply it in too great an amount, it will kill everything.

4380. Do you measure its fertilizing value by knowing the effect of using small quantities?—Yes.

4381. It would be no test of the value of an artificial manure to put it very largely upon the land, would it?—In agriculture, two and two do not make four, and an increase of the amount of manure gives less, in proportion, than it did before. It is just the same as all manures.

4382. The 3,000 tons appear to have given you a greater increase, in proportion, than the 6,000 tons, and the 6,000 tons to have given you a greater increase, in proportion, than the 9,000?—Yes; that is a law, no doubt.

4383. So that by increasing the amount of sewage you did not increase your crops proportionably?—No.

4384. Then does the same rule hold good both with regard to sewage and with regard to artificial manure?—Yes, certainly.

4385. Then in using sewage, you must measure its utility more by moderate applications than by enormous amounts?—Yes.

4386. In a Blue Book on "The Thames," which was issued a few years ago, you stated that the sewage discharged to Barking Creek would return to London. Is that your opinion?—I think a part of it would.

4387. Would it return in such a way as to be injurious to health and offensive to smell?—Not if it is deodorized there.

4388. In that same book it is stated that deodorized water stinks if it is kept; is that the case?—Yes, it becomes putrid again.

4389. You also stated in that Blue Book, that Essex would not do for the application of sewage, because it is too low, and that you could not drain away the water; do you still hold that opinion?—I think that there would be great difficulties about it; I do not say that it is not to be got over, but all the valley of the Thames is a very rich, fertile soil, and it is itself below the level of the Thames, therefore, you would have considerable difficulty in getting rid of that large quantity of surplus water.

4390. In your examination before the Committee of 1852, you stated that Essex would not do because it was too low, and because the water could not be drained away. Have you still the same objection to Essex?—I think there would be difficulties in its application there for that reason.

4391. A Mr. Thomas Lawes has sent a paper to all the members of the Committee; is he a relation of yours?—I have no relation of that name.

4392. Have you seen the paper?—No.

4393. Mr. *Tite.*] Are you a farmer at the present moment?—Yes.

4394. Where do you farm?—In Hertfordshire.

4395. To what extent?—I have about 500 acres.

4396. How long have you been a farmer?—Thirty years.

4397. That is since you were in business?—Long before that; directly I left college I began, and I have never ceased.

4398. However, you have been a practical agriculturist for 30 years?—Yes.

4399. You have paid great attention to the system of manures, and you manufacture manure?—Yes.

4400. Where is your manufactory?—At Deptford, and at Barking, on the Thames.

4401. Is that for the manufacture of superphosphate of lime?—Yes.

4402. Is it entirely confined to superphosphate of lime?—No; we manufacture artificial manures in general.

4403. Is it a very large business?—Yes; I manufacture very largely.

4404. You were one of the Commissioners appointed by Government with reference to the question of utilisation of sewage, were you not?—Yes.

4405. In that capacity, were you chosen to make certain experiments upon the utilisation of town sewage?—That was within the scope of our inquiry.

4406. But why were you employed at Rugby particularly?—Because the whole of my time almost has been devoted to the investigation of manures. I have a very large scientific establishment which does nothing else but experiment on manures, and I am supposed to be more interested in the subject than anybody else.

4407. Was it not deputed to you to make the experiments?—Yes.

4408. Were they left in your own hands?—Yes.

4409. And you were to take any course that you thought fit with regard to those experiments?—Yes.

4410. Why was Rugby chosen for your experiments?—Because it was one of the places where we could get the sewage delivered on the lands.

4411. How long were those experiments under your care at Rugby?—Two years and a half.

4412. I need scarcely ask you, as a man of honour, and a man of sense, whether you wanted to arrive at the truth, in making those experiments?—I wanted to arrive at the truth, as far as I could.

4413. It does not matter to you whether artificial manures are more or less used?—I have no interest whatever in the matter.

4414. Do you know Mr. Walker?—I just know him; but Mr. Walker does not reside at Rugby at all; his land is let to tenants, and we have taken our sewage from the tenants, and not from Mr. Walker himself.

4415. You have not communicated with Mr. Walker?—Very little, except to pay the rent of the land.

4416. Was the land chosen by you out of Mr. Walker's land?—Yes.

4417. Is it, in your opinion, a proper place for the application of the sewage?—I could find ground that would suit it better, but I could not find better places, where I could get the sewage delivered. There are very few places where you can buy sewage under present circumstances.

4418. You have not communicated with Mr. Walker, who differs entirely from you in his results?—I think he has not looked into the question at all; he is not an experimental farmer, nor an agriculturist. He has let his land to tenants, of whom Mr. Campbell is one, and has been so for a good many years.

4419. Would Mr. Campbell, the tenant, agree with this opinion, "I do not think that the results" (that is, the results of your experiments), "can be looked at as proving anything; the experiments, as regards agriculture, were conducted in such a way as not to show what sewage generally, or any given quantity of sewage, would produce"?—I think that Mr. Campbell would say that he had learnt a good deal from watching the experiments.

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4420. Do you think that the result of those experiments are likely to mislead the public?—Not at all, unless they wished to be misled.

4421. Do you think that Mr. Campbell has learnt a great deal from those experiments?—I am sure he has.

4422. With regard to his statement that, "The grass was allowed to grow extremely rank, till it was quite dead at the bottom, then it was cut, and the dry stubble, like stalks, left to dry a considerable time in the sun, and then, and not till then, it was watered again, and took a considerable time to revive;" is that the character of your experiments?—I do not say that such a thing may not have happened in the course of the last 2½ years, but I think it would always happen when you use a large quantity of sewage that some years you would have an immense and very rapid growth, and in other years you would have very little growth.

4423. Is it not the fact that, in using sewage, as in other things, there is a limit beyond which you do not get the value in proportion to the cost?—In all manure questions two and two do not make four. If you want to double your produce you must use more than double your manure; if you want to treble your produce you must more than treble your manure, and so on.

4424. In those experiments at Rugby, do you believe that you used more than was necessary to develope the character of the vegetation on the soil, or than was necessary to develope the vegetation itself?—The only answer that I could give to that would be what the sewage cost; I should use a great deal more than I use if I could get the sewage for nothing; I would use 20,000 tons per acre if I could get it for nothing.

4425. When an opinion is expressed that 600 tons per acre would be enough, you do not agree in that opinion, do you?—Certainly not.

4426. Did you use enough sewage in your experiments to enable you to test the accuracy of that opinion?—Yes, because at Edinburgh they use a much larger quantity, and get a much larger result.

4427. On the other hand, if you had used a less quantity you would have had a less result, in your opinion, is that so?—No doubt of it.

4428. You have not made experiments at any other place than Rugby, have you?—No.

4429. You continued the experiment as long as it was useful, did you not, and you were at liberty to continue it longer?—Decidedly.

4430. Did you continue it long enough to obtain the results which you have given, and which you have printed?—Yes; some of which I have printed, and I am going to print others.

4431. Are you a chemist practically?—I have studied chemistry all my life, ever since I was a boy. I am not in business as a chemist; but it has been my particular pursuit.

4432. Have you ascertained whether one class of sewage-water contains more of the manurial elements of sewage than another; if so, is Rugby well placed, or ill placed, in that respect?—I should say that Rugby was better situated than London, and that the sewage would be of a better quality in Rugby than in London, that is to say,

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say, less diluted. We have taken extreme care to get an analysis of the sewage at Rugby.

4433. Have you the same analysis as to the London sewage?—We have not actually analysed the London sewage; but by inference, you can get very close to the quality of the London sewage by experiments.

4434. How were those analyses conducted at Rugby?—The sewage was pumped into two tanks, containing from 3 to 4 tons, one in each field, and every two hours, while it was pumping in, samples were taken, which were put into glass carboys, and those were forwarded from time to time to Professor Way; in all there were about 100 analyses made of the sewage in two and a half years, and we sampled about 100,000 tons of sewage in that time. It is quite possible that Professor Way may not have those tables; they are all calculated in my office. In the first year, 1861, there were 6·39, or nearly 6½ grains of ammonia in a gallon of sewage water; in 1862 there were six grains; in 1863 there were 6·75 grains of ammonia, those two years giving a mean of 6½ grains to the gallon: 1862 was a wet year, and 1861 and 1863 were dry years; supposing you calculated it according to the quantity per ton, there are between three and four ounces of ammonia in a ton, and 2¾ lbs. of dry matter.

4435. Of what is that dry substance that you allude to composed?—One half of it consists of dirt and of things that are washed into the sewers, and the other half consists of potash and phosphoric acid, and a variety of salts.

4436. Are those salts useful?—Some of them are very useful.

4437. *Chairman.*] The phosphoric acid is in the state of a salt, is it not?—The phosphoric acid is in the state of phosphate of lime, and phosphate of potash.

4438. Is phosphate of lime a soluble salt?—Yes.

4439. Is phosphate of potash also soluble?—Yes; I am giving you the dry matters in a ton of liquid sewage.

4440. Mr. *Tite.*] What is the commercial value of those substances, supposing I bought them in the market?—The commercial value of the whole is equivalent to reckoning ammonia at 8 *d.* a pound; that would be 1½ *d.* for the fertilising ingredients if taken out dry and packed into bags. That would be 1½ *d.* a ton for the sewage as we take it from Rugby.

4441. Lord *Fermoy.*] Is that for the ammonia alone, or for the fertilising matters altogether?—If you valued the other things you must value the ammonia at less than 8 *d.* per pound.

4442. Then, in fact, you value the fertilizing matter of a ton of the Rugby sewage at 1½ *d.*?—Yes.

4443. Do you attach no value to the fertilizing matter of the liquid?—No, not if I valued the dry matter at that amount.

4444. You do not consider that the use of that liquid going over the land would be any use as irrigation at all?—Not taking 1½ *d.* as the value of the solid matter. If you were to ask me to value the liquid as a liquid containing only three ounces of ammonia to the ton, I should say it would be very much less valuable than that.

4445. In fact, you really value the sewage, liquid and solid altogether, at 1½ *d.* a ton, is that so?—I think that the value of it is what it is worth to produce, and at different periods that varies. I only value the ingredients at what they would fetch if you took them out and sent them into the market.

4446. In fact, you do not consider it worth 1½ *d.* a ton?—Certainly not.

4447. You stated just now, in answer to a question of the Honourable Member for Bath, that looking at the irrigating with sewage in some years the growth of the crops was very rapid, and in other years much less so?—No doubt it is so.

4448. To what do you attribute that?—To the want of temperature.

4449. In some years you have a much hotter sun than in others?—Some years are much hotter than others, and there is then much more growth. In fact, when you have moisture you always require temperature in proportion.

4450. You state that you consider the Rugby sewage much more valuable for fertilizing purposes than the London sewage, is that so?—I think it is less diluted; there is more water mixed with the London sewage.

4451. How do you arrive at the value of the London sewage so as to make that comparison?—The plan by which I have tried to arrive at it is by estimating what proportion the total sewage of Rugby bears to the water supply, and what proportion the sewage of London bears to its water supply in the same manner; and I find that the water supply of London is very much larger. I believe that the water supply and the sewage of London approximate to 100 tons per head per annum, and that of Rugby to about 60 tons per head per annum. I think the referees estimate the sewage of London at 328,000,000 tons per annum. Mr. Bazalgette estimates it at 268,000,000, a comparison of those two quantities gives a mean of 298,000,000.

4452. You say that at Rugby you get three crops of grass in the year?—We cut five or six crops in the year.

4453. Do you go on improving in point of quantity in each year?—Last year was the best year, but then it was a very favourable year for growth altogether, it was very warm and very dry. The produce depends a good deal upon the climate of each year.

4454. Then you do not think that going on from year to year you improve the staple of the land at all?—Not very much. At this moment we have stopped the sewage, and no doubt larger produce will come off than if we had never put any on.

4455. Applying that rule to the portable manure, of which you have had considerable experience, do you mean to say that if you went on using Lawe's superphosphate of lime year after year you would not improve the land?—Very little; the effect of artificial manure is more or less exhausted in the first year.

4456. Are you of opinion that it leaves the land, *quoad* land, no better than it finds it?—The first year would be better; no doubt there are latent manures in the soil which are stimulated by the application of the sewage.

4457. From your experience of portable manure, do you mean to say that, no matter what quantity of it you put upon the land, it leaves the land no better than it found it, *quâ* land?—Not materially.

4458. Therefore if you went on year after year manuring with Lawe's superphosphate, though you would get a larger amount of crops, you

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you would still leave the land no better than you found it?—Very little.

4459. Mr. *Ferrand.*] Have you ever seen sewage applied to pasture land?—This is pasture land that I have been alluding to; I have seen it applied to grazing land.

4460. To what amount have you seen it applied?—They are applying a large quantity at Croydon at the present time, and grazing a part of the land.

4461. Have you any idea of the number of tons which are applied per acre?—I believe at Croydon they apply 6,000 tons per acre for pasturage.

4462. Have you ever seen a less quantity than that applied?—I cannot say that I have; I do not know where there is any less quantity of sewage used.

4463. In your opinion what would be the effect of the application of 1,000 tons per acre?—It would improve the crop considerably.

4464. Do you think it would double the production?—No, I do not think it would, but it depends a good deal upon the quality of the sewage. The whole question turns upon what is in the water, and not upon the water itself.

4465. Have you ever seen sewage applied from a dozen cottages, or from a country house, to grazing land?—I can hardly call that sewage; that is liquid manure. The manure from a country house may be 10 or 12 times the strength of sewage; it is a question of dilution.

4466. What effect has sewage upon very sandy soils?—It is, perhaps, more adapted for a sandy soil than any other; you get rid of your water quicker.

4467. For instance, if 30,000 acres of sandy soil could be found within 20 or 30 miles of London, and the sewage of London were laid upon that sandy soil, would it not, in your opinion, be very largely improved in a very short period of time?—Immensely improved.

4468. Would the sandy soil gain solidity by the London sewage being laid upon it?—It would, no doubt.

4469. Mr. *Sclater Booth.*] You have stated, have you not, that cattle could not be fattened upon the sewage grass?—I think they could not well be fattened upon it, if it were cut.

4470. But you did not go on to say what you thought was the best application of the sewage grass; will you state your opinion upon that point?—I think, for producing milk, it is well adapted.

4471. That is, by being cut and carried?—Yes, that is the most economical way of using it.

4472. Then you state that a scheme for utilising the sewage of the metropolis in that way, that is to say, with the view of producing grass on a large scale, would so far be a profitable scheme?—Yes. I cannot conceive that sewage is really adapted for producing anything but milk profitably; it is a very weak grass that it produces, containing an immense amount of water, much more than common grasses contain; but it seems to be admirably adapted for producing milk.

4473. You stated that, in your experiments at Rugby, the sewage ran away in drains, and I rather gathered that you inferred from that that the sewage, flowing away in the drains, was a sign of the limited capacity of the earth in receiving the manurial qualities, which are in suspension in the sewage; is that your view?—No doubt.

4474. Might it not be that it was an imperfection in the mode of distribution over the land, or from the drains being too near the surface, that the manurial properties were enabled to escape?—I suspect that, when land is saturated with water, the power of retention of those ingredients is very much stopped; the land has no such power to retain those ingredients as it would have in a dry state.

4475. Then do you consider that a very sandy soil, drained to a greater depth, would have a greater property of absorbing those manurial elements than this land?—A much less property.

4476. Do you think that the sewage would flow through it more quickly?—More of it would be retained on a heavy soil.

4477. But sand or gravel is the substance which is used for filtering water, is it not?—Yes; and it would filter a great deal more water. The difficulty would be, to get rid of the water, if you look at the very diluted state that the sewage is in.

4478. But, supposing that there were no difficulty about getting rid of the water, would not a soil which partook of the nature of a filter have a greater power of taking away from the sewage the whole of the substances which it had in suspension than a heavier soil?—But the valuable part of the fertilising matter is really not in suspension, but in solution; it would filter the suspended matter better.

4479. Would not the drainage from a bed of sand come out cleaner than from your farm at Rugby?—I dare say it would.

4480. You mentioned that the greatest quantity of grass that you got off land, which had been manured with dry manure, was 12 tons, and that the greatest quantity that you got from land manured with sewage water, was 32 tons. Can you inform us as, between those two qualities, what would be the outside produce from a good water meadow?—I should think, perhaps, a good water meadow would produce 15 tons.

4481. Then it is quite clear, from the whole of your evidence, that you do not attribute much importance to the irrigation of land by means of sewage water, looking upon the sewage merely as a watering of the land?—Very little.

4482. Do you consider that such land as you have experimented upon at Rugby is not permanently improved by the sewage that has been placed upon it; supposing that a bed of sand were treated in that way, would it not, in process of time, be converted into something approaching to soil?—A bed of sand, if so treated, might be worth in a few years 100 *l.* per acre to sell.

4483. Assuming for a moment that the flow of sewage over that land would stop for ever, would not that be reclaimed land?—Yes; by degrees you would get a deposit of fine alluvial soil.

4484. Sir *Joseph Paxton.*] What is the nature of the subsoil at Rugby?—It is a clay subsoil.

4485. What is the surface soil?—What we should call a heavy loam; it is, comparatively speaking, a heavy soil.

4486. Then if you had a very large quantity of sewage to apply to that land, you would not get rid of it at all?—No; one field is on a slope, and therefore it filters through pretty quickly, but the other is rather more level.

4487. If the soil is clay, the sewage could only penetrate to a limited depth during the time of its application, could it?—No doubt it can only penetrate to a limited depth, and then it drains away.

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4488. Should not it, if drained over clay as you have described, cause the best parts of it to be more easily carried away by the drains and the ditches; in fact, the land would not absorb it and the plants would not absorb it; are you not aware that the soil is also a deodorizer?—No doubt of it.

4489. Would not a soil that could be penetrated very easily be better than this clay subsoil?—I dare say it would be; of course, when a clay subsoil is really saturated with water, you cannot expect much absorptive effect from earth containing such an immense amount of liquid as this does.

4490. If you had had to pick out a place to apply the sewage, would you have taken that place?—Not if I wanted to take the best results possible, but you are obliged to adapt yourself to circumstances; every place is not like Edinburgh, with a sandy soil running away to the sea.

4491. If you had a town where it was desirable to deliver the water as clear as possible into the river again, what would be the soil that you would choose for that purpose?—If I had to deliver a large quantity of sewage upon a small area I should take a sandy soil.

4492. That would purify it better than anything else, would it not?—I think so; it would filter it perfectly free from all impurities.

4493. You stated that you did not do anything to the water; for the growth of those plants is not a great deal of water application necessary?—No doubt; you cannot by any solid manure produce the same result as by liquid manure up to a certain point, but as a general rule we have a very large quantity of water in our soils besides that supplied by the atmosphere.

4494. You use liquid manure, do you not?—Not at all.

4495. What do you do with liquid manure that you make about your own homestead?—I absorb it as well as I can with the farmyard dung.

4496. Can you tell me what will be the quality of the sewage water if it passed through a bed of sand, impregnated with iron, of 20 or 30 feet deep, with a vegetable surface on the top?—If you did not put it on in too large quantities, no doubt the greater portion of the salts would be separated from it.

4497. If it had to pass through 8 or 10 miles, that would be still better?—Yes, no doubt.

4498. You state that you put the sewage on every month in the year; do you consider that it would be right to put dung upon the land every month in the year?—No, certainly not.

4499. Then why would you put sewage on the land during every month?—Because those that have sewage, and buy sewage, are obliged to get rid of it as it comes, day by day.

4500. You put it upon the land because you are obliged to put it there; is that the reason?—Because I am obliged to get rid of it.

4501. Did you divide this land into small portions in order to apply a certain quantity of sewage week by week, or month by month?—It was divided into fields of four acres each.

4502. If you had had a larger surface to deal with, do you think that that would have been better?—The reason why we use this large quantity seems to have been very much misunderstood; but the Commissioners have visited all the different towns in England, and seen whatever was done in the application of sewage, and they found, generally, that those who had covered their land with pipes had begun to give up the use of those pipes, and to concentrate the sewage. When they visited Mr. Walker's farm, they found 450 acres piped for the sewage; but the tenants had abandoned the pipes, and were beginning to use the sewage in a concentrated form, to use it in large quantities on a small area, and therefore the Commissioners did not think it worth while to spend the money of the country in doing what had already been found out to be disadvantageous.

4503. *Chairman.*] Was any of the money of the country spent in those experiments which you have made?—Yes.

4504. Did not you state that every one who carried on those experiments was unpaid?—The members of that Commission were not paid; we had a grant, to apply as we thought necessary, and the grant was employed in the paying for the sewage, the rent of the land, and the labour; we bought the sewage delivered to us at a certain price.

4505. Sir *Joseph Paxton.*] I think I understood you to say that you did not use Italian rye-grass?—Yes, we used it last year.

4506. Do you like that better than the other grasses?—The results are almost equivalent, whether we put the sewage upon rye-grass, or upon pasture grass.

4507. Upon what pasture grass did it answer best?—It was all alike; it was entirely pasture.

4508. But there are several different grasses on pasture land; to which kind did you apply the sewage?—I cannot answer that question, because when you put the sewage on it, it begins to alter immediately; if you took a botanist to look at the plants before you put the sewage on, and then showed it him after he would see a total change in three years.

4509. Do you know the cocksfoot grass?—Yes.

4510. Did that produce to a great amount?—No doubt it did, because it would change the quality of the grass.

4511. Have you ever tried that cocksfoot grass?—Not separately from other grasses; I cannot give an opinion as to the quality of different grasses.

4512. Mr. *Bright.*] You stated that you found that the farmers had given up the use of sewage over large tracts of land, and now used it in a concentrated way; was that because they found that a so much more profitable result was obtained when it was applied in a much larger quantity than was possible over a much larger area?—They found that small quantities of sewage which they expected to do a great deal did not do it.

4513. And, therefore, that leads you to the conclusion that sewage is only useful when it can be had in abundance, and when a great quantity can be laid over every acre of land?—That is exactly the case.

4514. Mr. *Leader.*] Have you ever been to Alderman Mechi's farm; I believe that gentleman has paid great attention to the subject?—Yes, I have been to Alderman Mechi's farm.

4515. He states in his evidence that town manure is three times as strong as the manure that he pumps over his farm, and still he values that manure at somewhere about 3 *d.* a ton; that is quite different from the result of your experience, is it not?—I read a paper of Alderman Mechi's this very day which was published on Saturday in one of the leading agricultural journals.

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journals. He says that it is well known that 200 tons of sewage contains as much fertilizing element as 3½ cwt. of guano, but my impression is that it does not contain one half of that. The tendency of all the recent examinations which have been made of the sewage, has been to reduce the previous estimates of its quality, and a more accurate investigation has taken place at Rugby, and it seems that as the metropolis is becoming more abundantly supplied with water, the sewage is more diluted every year. Professor Way commenced an examination of the sewage. His first analysis gave 17½ grains of ammonia per gallon, and I believe now he would probably state that there were not more than five grains per gallon.

4516. Mr. *Caird.*] Then the value of the sewage to a town at the present time might not be a fair criterion of what it might be worth at some future year if the supply of water should go on increasing?—It would become worth less and less.

4517. The quality of the sewage would gradually diminish, would it not?—Yes; the supply of water increases faster than the population.

4518. The proportion of water to the population, so far as you have seen, has been on the increase, has it not?—That has been the tendency up to the present time.

4519. In consequence of instructions from the Committee which sat in 1862, did not you continue your experiments upon sewage-grass at Rugby?—Yes.

4520. Have you obtained any additional results in confirmation or in contradiction of those experiments which you at that time published and stated before the Committee?—So far as the grass experiments were continued we have only confirmed what we stated before; but we have experimented upon rye-grass, and, to a small degree, on a corn crop.

4521. Then, what farther light has the progress of your experiments thrown upon the value of the sewage?—It has taught me to form a tolerably accurate conclusion as to what I should like, as a farmer, to give for it. I am beginning to arrive at a practical knowledge from these experiments what it would be worth to me.

4522. As your experiments at Rugby were carried on with a certain quantity of sewage which you had analysed, what would you say, as a farmer, you could afford to pay per ton for the use of that sewage on growing crops?—The question is, whether I receive the sewage when I like, or whether I am to take it all the year, because it makes all the difference; it is of very little value in the winter months, when the land is saturated with moisture, but if I could have the sewage turned on as I required it I would give a much larger price for it immediately.

4523. Supposing that the sewage from a great city, like London, must be taken off as it arises, and that you, as a farmer, must take it as it is sent to you during the whole year round, what price per ton could you afford to pay for it, it being delivered to you at your farm, you paying the expense of all the sub-piping and carriage of it throughout your farm?—Below ½ *d.* per ton.

4524. Could not you afford to give ½ *d.* a ton for it delivered on your farm?—No.

4525. Taking it as you yourself would desire to take it, and in such quantities as you would desire to have it, what price could you afford to pay for it?—Two-pence a-ton.

4526. Then you make a distinction of 1½ *d.* a-ton between the obligation to take it when you did not want it, perhaps to the injury of the crops, and the liberty to take it when you required it?—I would rather give 2 *d.* for the one than ½ *d.* for the other.

4527. Do you take into account the necessity that you have in the one case to use a much larger quantity than in the other, and therefore to pay in the year for a good many more tons than you would in the other case, if you had to take it when you did not require it, as you would probably have to take it?—I am assuming that in the one case that I should take it at the rate of some 1,000 tons a-year if I required it in the summer time, and, in the other case, that I should have to take it all the year round, but that in each case the quantity would be 1,000 tons.

4528. But supposing that the necessity lay upon you to take 2,000 tons, inasmuch as you must take it in order to relieve the sewage pipes, and that in the other case you were not obliged to take more than you required, that is, than your 1,000 tons, would not the difference between the 2,000 and the 1,000 form a large element in the difference in price that you could afford to pay for the sewage?—No doubt.

4529. Have you calculated that circumstance at all in arriving at the comparative prices of ½ *d.* and 2 *d.*?—I have assumed that if I pay 2 *d.* a-ton I take it in quantities as I require it.

4530. Then if you were obliged to take the sewage in larger quantities, you calculate that it would become still less valuable to you; that is what you have stated to us?—No doubt.

4531. Have you estimated in what way that might be?—I cannot say that I have; but, for instance, in such a year as 1862 the sewage would be of very little value at all.

4532. That was because the season supplied you with a greater quantity of water than the sewage, was it not?—Exactly; we found that sewaged grass of that year produced less effect with oilcake than the sewaged grass without oilcake in the year after.

4533. Sir *Joseph Paxton.*] That is with regard to the temperature?—No doubt.

4534. Mr. *Caird.*] A question has been put to you, as to whether you thought the use of the sewage of London upon the Essex marshes would be advantageous or otherwise; did you not state that the country lay too low for the proper application of it?—I was referring to the valley of the Thames exclusively.

4535. You do not refer in any way to the higher lands in Essex, to which the sewage might be pumped, do you?—No.

4536. Was your answer entirely with reference to the low marsh lands along the banks of the Thames?—Exactly.

4537. Have you considered the subject of the application of the sewage of the metropolis for agricultural purposes, and if so, will you state to the Committee what, in your opinion, is the mode which, from your experience, you would recommend should be adopted?—I believe, in the interests of the ratepayers, that the only possible chance they have of obtaining any benefit from the sewage is to deliver it by gravity, taking a very large tract of ground. If you come to pump the sewage at all, the cost is so great, and the area that you must deliver it over is so great, that I do not think it would pay the cost.

4538. But do you not consider that the low lands

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lands along the banks of the Thames are not suitable for the application of the sewage, and that, therefore, it must be pumped, in the first case, to some high point, from which it might descend by gravitation?—I would rather take the low lands, and apply the sewage over them, than pump it; I think it would be more profitable to do that than to pump. When you come to pump such a diluted fluid as that, the cost is very largely increased.

4539. Have you paid any attention and made any experiments as to the engineering part of the question?—Of course I have paid attention to it, but the Committee have already had much better evidence than I could give upon that head.

4540. What description of land would you consider the most suitable for the application of the London sewage?—The lightest land that you could get; a porous, sandy land.

4541. Such as Bagshot?—Yes.

4542. Or such as sandy land reclaimed from the sea?—Decidedly, because then you have no natural produce, and no cost to begin; whereas, if you take a heavy land on the banks of the Thames your rent is 4*l.*, or something of that sort.

4543. You look upon a large profit, from converting something which is almost worthless into something very valuable?—I should, certainly.

4544. With regard to the crop that you would grow with the sewage, taking into consideration the necessity that there must be of applying the sewage from the metropolis, as it arises day by day throughout the year, to what kind of crops do you think the sewage could be most advantageously applied?—Principally to pasturage.

4545. Do you mean grass for mowing?—For feeding cattle principally, for producing milk; if you could sell your green grass up to that point, of course you would do it.

4546. Have not your own experiments shown that the largest returns have been from grass converted into milk?—Yes, they have; we have produced on one acre, I think, in one year as much as 1,500 gallons of milk.

4547. Then the sewage, converted into grass, has been most profitable when that grass has been converted into milk, has it not?—Yes.

4548. May we draw that conclusion from the experiments conducted by the Commission?—No doubt.

4549. Would you, therefore, conclude that the conversion of grass into milk near the metropolis would be the most useful means by which sewage could be applied?—Yes.

4550. Does it also seem to you that its conversion into meat would be profitable?—To a certain extent; but not to the same extent as milk.

4551. Have you found that sewage grass can be profitably used for the feeding of cattle?—Not without artificial food.

4552. Can the grass be profitably used for the production of milk without artificial food?—Yes.

4553. Can the sewage be given to crops the whole year round continuously with advantage as they grow?—You would have none in the winter; of course you must either make it into hay or buy something else.

4554. Is the average description of produce that you can get from the fields to be compared with anything else that you can get on the ground?—You might get rye-grass a little earlier perhaps.

4555. Between rye-grass and pasture grass your comparison will arise?—Yes.

4556. With regard to those vegetables for which this sandy land is very suitable, have you made any experiments to ascertain the returns upon the growth of potatoes, peas, cauliflower, cabbage, and such culinary vegetables, by the application of sewage?—I have made no experiments whatever.

4557. Have you tried the pasturage of cattle upon the ground where the sewage has been applied without mowing the grass?—No, not at all.

4558. Then when you talk of feeding cattle upon the sewaged ground, would you propose to graze them upon that, or would you propose to cut the grass, and feed them in yards or houses with it?—I should propose to do what I think is being done at Croydon now; they are obliged occasionally to buy oxen and pasture them upon the ground, but I think it is not the most economical way of using the sewage.

4559. Then are we to take it that, in your opinion, you expressing, as I understand, the opinion of the Royal Commission, the experiments have led you to conclude that the most profitable application of sewage is to the production of grass for the feeding of milch cows?—Yes.

4560. And that next to that it would be profitable to feed cattle with sewaged grass?—Yes.

4561. That from those two modes of using the sewaged grass the greatest profit could arise?—That is so.

4562. What quantity of sewage per acre, supposing you had received authority from the Metropolitan Board, or whoever has the power of giving authority, to do the whole thing yourself, would you reckon as a proper application of the sewage of London for the production of grass?—I should think that, perhaps, 6,000 tons would be as much as I should wish to use upon an acre if I could get a suitable district for it.

4563. Would it depend somewhat upon the nature of the soil whether you would use 4,000, 6,000, 7,000, or 8,000 tons per acre?—It would depend a great deal upon the nature of the soil.

4564. If the soil were a light sandy porous soil, 30 or 40 feet deep, would you propose to use a larger or a smaller quantity of sewage upon that soil?—It would depend very much upon where I could get the land. I should like to use it like an irrigated meadow from field to field. Your real object is to get all the elements you can out of the sewage.

4565. Supposing that you could let the sewage pass throughout the land from the top till it came gradually out at the bottom, what amount per acre would you calculate as the most profitable quantity to apply that sewage?—I should think 6,000 tons per acre, but it depends a great deal upon a number of circumstances which it is very difficult to take into consideration.

4566. Upon a heavy soil you would put a smaller quantity than upon a light soil, would you not?—Yes; I would use a great deal more rather than pump it.

4567. Putting aside altogether the question of pumping, and dealing with the sewage as delivered to you in any quantity that you desire to apply it in, having it so delivered, what is the quantity of London sewage that you would think the most profitable quantity to apply upon the land in order to give yourself and the persons who

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who sold it to you the largest return permanently, because it is only upon the principle of mutual advantage that the thing is likely to continue?—Looking to the interest of both parties, I should say about 6,000 tons per acre; as a tenant, I should say, 30,000 or 40,000 if you gave me the sewage. If you wanted to charge for it, I should confine myself to something about 6,000.

4568. Have you considered what you could afford to pay for that 6,000 tons delivered on your land throughout the year, that being the necessity of the case?—I should not advise any friend of mine who came and consulted me, to give ½ *d.* a ton for it. I should say that it was a great risk. I do not say whether he would make a profit upon it or not.

4569. That would depend somewhat upon the nature of the soil to which it is applied, and upon its proximity to the cities where he would send the produce?—No doubt; but when you get near towns, you cannot sell your produce so well, because you have so many competing substances.

4570. Applying 6,000 tons an acre as the quantity of sewage which comes from the metropolis, do you know over how many acres of land the whole of the sewage of the metropolis could be profitably applied in that way?—It would be about 50,000 acres.

4571. From your experience, would you consider that an ample area for the utilisation of the whole sewage of London?—Yes; but if I could get the means of going lower, I should like to do that, that is, if you could get 50,000 acres, with more land besides, that you could irrigate without pumping, I should prefer a larger area.

4572. Over which the water might run after it had already irrigated those 50,000 acres?—Yes.

4573. So that you might extract the greatest benefit possible from it?—Yes.

4574. But would you not consider that those last acres, over which the weakest portion of the sewage ran, would be so profitable to you as that land which received the larger and better portion of the sewage?—Nothing approaching to it. If you put 50,000 tons on one acre, and 30,000 tons on another, you would find the 50,000 tons is very much the more profitable application.

4575. Do you think that 500 tons an acre of the sewage of London would produce any benefit to the person using it?—Yes; if you gave it to him.

4576. Could you afford to pay ½ *d.* a ton for 500 tons of sewage applied to an acre of land?—I have not calculated the cost of the application; I do not know what it would cost to deliver those 500 tons; the smaller quantity you use the more it costs you per ton in general.

4577. Do you not find in agriculture, that the more you can concentrate your power, the more profitable it is likely to be to you?—Yes, no doubt.

4578. In a country like this, where land and labour are comparatively dear, and where capital is comparatively cheap, would you not think it an advantage to endeavour to obtain from the smallest space of ground the largest quantity of produce, by the concentration of capital and power?—Yes.

4579. Mr. *Bright.*] Will you tell the Committee what is the cost, per acre, of the application of guano as a fertilizer, as it is ordinarily used, assuming an average quantity to be applied to the land?—From 30 *s.* to 40 *s.* a year.

4580. If you were to put 6,000 tons of sewage on an acre of land, at ½ *d.* per ton, that would come to about 12 *l.* per acre, would not it?—Yes, I dare say it would.

4581. Then how do you come to the conclusion that it would pay a farmer to expend 12 *l.* an acre in manure, by the use of town sewage, when it only pays him to expend 30 *s.* or 40 *s.* an acre in the use of guano, which is a manure that is well known, that is of a definite quality, whose result he can calculate upon, and which he can employ at almost no expense?—He would immediately adapt himself to the different circumstances. It pays the Edinburgh men to pay 30 *l.* or 40 *l.* an acre for this land, although a common farmer only gives 1 *l.* for it.

4582. Then he must change his mode of agriculture, and revolutionize his whole industry?—Yes, entirely so.

4583. Mr. *Caird.*] The application of sewage is quite a special mode of farming, different from the ordinary farming of the country, is it not?—Totally different; it ought to be a system of itself.

4584. *Chairman.*] You stated, did you not, that you considered that sewage was not worth a halfpenny a ton?—I said I should doubt whether anybody would be likely to use it at that price; I am speaking of the ingredients of the sewage.

4585. You are aware that Professor Way has analysed sewage, are you not?—Professor Way has analysed every particle of the sewage which I am now referring to for the Commission.

4586. Do you know that he has published analyses of two specimens of sewage in the Royal Agricultural Society's Journal?—Yes.

4587. One was a very poor specimen from Dorset-square, and the other was a better specimen from Barrett's-court?—Yes.

4588. Are you aware that he states that, of only two of the ingredients in 10,000 gallons of the sewage from Dorset-square, namely, ammonia and the insoluble phosphate of lime, the value was 13 *s.* 6 *d.*?—Yes.

4589. The amount of those two ingredients being worth 13 *s.* 6 *d.*, would give you a value of 3½ *d.* for the amount of those two ingredients alone contained in a ton of sewage?—Yes.

4590. There is a considerable difference between the halfpenny, at which you have put it, and the 3½ *d.*, at which Professor Way put it?—A very great difference; but my estimate of the London sewage, according to the ingredients, is 1 *d.* per ton.

4591. When Professor Way takes the value of the whole of the ingredients of a ton of sewage from Dorset-square, it appears that the value in pence amounts to 4·7 per ton; is not that the case?—Yes.

4592. With regard to the Barrett's-court sewage, the amount of ingredients in a ton of sewage appears, by Professor Way's analysis, to be worth 1 *s.*; are those analyses correct?—No. They are correct so far as the very samples, to which he referred, are concerned; but they have no reference to the quality of London sewage as a whole.

4593. Did he not take a fair sample of the Dorset-square sewage, and another fair sample of the Barrett's-court sewage?—Yes; that was on a certain day, and that was the composition of that sewage at that moment; but it has no reference to the quality of the sewage at Barking and Purfleet.

4594. Do you mean to say that he took it out

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on some day that would not give a fair average?—Not at all.

4595. Are you aware on what day he took it?—No, I am not.

4596. Do you consider that those analyses, which were published in the "Royal Agricultural Society's Journal," give a true description of the sewage from Dorset-square and Barrett's-court?—Yes, no doubt they do.

4597. That sewage flows out with all the other sewage into the outfall, does it not?—Yes.

4598. Do you think that Professor Way cannot arrive by that means at a fair knowledge of the composition of the sewage of London?—No.

4599. If Professor Way knew the value of the poorer sewage and the value of the richer sewage, the value of the whole body of the sewage must be something between the two, must it not?—It must be something between the two; but if you have one very rich sample of sewage and one very poor sample, the mean of those may not be the average.

4600. But must not the average come somewhere between the richest and the poorest?—Yes.

4601. The poorest being worth 4·7 *d.*, and the richest being worth 1 *s.* the average must be more than 4·7 *d.*, and less than 1 *s.* must it not?—Yes, I will allow that.

4602. Then on what ground do you state that the sewage is not worth a halfpenny a ton?—Because I say that that analysis did not represent the composition of the London sewage as a whole.

4603. How are you aware of that?—Because I have paid a great deal of attention to the subject for some years.

4604. Have you analysed the sewage?—No, I have not.

4605. Do you say then that Professor Way's analysis of the sewage is incorrect?—I say that his analysis is correct, but that his inference is not correct.

4606. Will you state the grounds on which you found that belief?—Since Professor Way made those analyses a great deal has been done in investigations as to the sewage. Doctor Letheby analysed all the sewage night and day for some time, and he says that it contains a little more than six grains of ammonia per gallon, and that, for instance, is more correct than Professor Way's analysis.

4607. How do you know that it is more correct?—Because he gives a great many more examples.

4608. You state that one person has given you one analysis, and that another person has given you another analysis, but unless you have tested it for yourself, you cannot state which is the more correct of the two?—I can state with great confidence that one is correct, and that the other is not.

4609. Has not Professor Voelcker examined the sewage and analysed it?—Yes, he has.

4610. Are you aware that he gives 4·6 *d.* as the value of the ingredients in a ton of sewage?—Yes.

4611. Does not that bear a very curious analogy to the results of Professor Way's analyses?—You must take one opinion against the other, and I say that Professor Way is incorrect.

4612. Is that your supposition, or do you state it from your own knowledge?—I state it from my own knowledge.

4613. Have you analysed the sewage?—No.

4614. Then how do you know which is the more correct?—I have taken great pains to estimate what is the composition of the excrementitious matter of a human being.

4615. How did you obtain that?—By combining together a great number of careful analyses which had been made by myself and other scientific men.

4616. You give a certain amount as the value of the excrementitious matter, must not the sewage itself be worth as much as that?—But you get with the sewage the amount of rain-fall which is likely to run into the sewers.

4617. Do you add to that all the detritus which is washed from the streets?—Yes.

4618. Do you not think that the shorter and more correct way would be to take the sewage itself and analyse it?—We have done it at Rugby.

4619. If you state that Professor Way's analyses are to be taken as correct analyses of the Rugby sewage, why may not his analyses be taken as correct with regard to the London sewage?—Professor Way is not for a moment going to say that his estimate of the composition of the London sewage at the present time is correct, or that he thinks it is. We have learnt a great deal about sewage during the last few years.

4620. Are you aware that Messrs. Hofmann and Witt analysed the sewage in the year 1857?—I am.

4621. Do you know the value which they put upon the sewage?—I think I do.

4622. Did they not state that the Barrett's-court sewage was worth 12·3 *d.* per ton?—Yes; but then that is without rain-fall at all; that is dry weather sewage.

4623. Do they not state that 1,250 tons of sewage contains an amount of fertilising matter equal to one ton of guano?—They say so, but I do not think so.

4624. Do you think that what they say is incorrect?—I do.

4625. Why so?—Because I do not think they allow for the dilution of the sewage.

4626. Have you looked at their report?—Yes, I have read everything that is known upon the subject.

4627. Do you mean to say that they did not take the rain-fall into the calculation?—I believe that they did not.

4628. Have you looked at it so as to know whether they did so or not?—Yes; I believe that they did not.

4629. Are you aware that the sewage during a storm flow of rain is richer in fertilising matter than the ordinary sewage?—It contains a great deal more suspended matter, but I am not sure that it is more valuable matter.

4630. Is not "fertilizing matter" their expression?—It is more suspended matter, I think.

4631. If it be the case that it is richer than the ordinary sewage, then they have taken a sample of the sewage which is less advantageous than if they had taken it in dry weather; is not that so?—Probably there would not be a great deal of difference. Perhaps I may be permitted to state that we have gauged the Rugby sewage very carefully, and I can give the difference between the highest and the lowest quantities of ammonia in a gallon of sewage in different years. In 1861 the lowest sewage that was analysed contained rather less than 3 grains of ammonia per gallon, and the highest contained 15½ grains. In 1862 the lowest sample of sewage contained 2½ grains of ammonia per gallon, and the highest contained 11 grains. In 1863 the lowest sample contained 3 grains per gallon, and the highest contained 12 grains; so that there is a very considerable difference. Therefore, if you take one or two samples and try to calculate by them, your calculations will of course be erroneous; but if you take the samples of two or three years together, you will arrive at a very close approximation to the truth.

4632. How many tons of London sewage would you take as containing fertilising matter equal to one ton of guano?—About 3,000 tons of sewage.

4633. Does that quantity contain an amount of fertilising matter equal only to one ton of guano?—150 tons of London sewage would, I think, contain as much fertilising matter as one cwt. of guano. I consider that there are from 12 to 13 pounds of ammonia in 100 tons of London sewage, and there ought to be about 16 pounds in one cwt. of guano. I put rather a higher value on the ammonia merely to simplify the matter.

4634. You estimate the sewage in a sort of rough-and-ready fashion, do you not?—No; but if I went into those very minute calculations I should take a very long time to work them out. Ammonia is of so much higher value than anything else in manure, and the other things are so sure to follow ammonia, that it is a very good way of calculating the value of manure.

4635. You have stated that all depends upon the strength of the sewage, that you preferred the strong sewage, and that the weak sewage is of no value?—Comparatively, it is of no value.

4636. Did you read the report of the Commission before it was presented?—Yes, certainly.

4637. Are you aware that that report, in referring to the case of Milan, says that, "although the water used for irrigation receives little or nothing of the solid excrement of the population, and is so dilute that it is hardly to be distinguished by the senses from ordinary stream water, yet it confers upon the land to which it is applied an increased value of from 4 *l.* to 5 *l.* per statute acre per annum above that obtained for land irrigated by streams containing no sewage"?—I have no doubt that that is the case.

4638. Although it receives little or none of the excrementitious matter of the population?—"Little or none" is rather a vague term.

4639. Do you think that any of the London sewage is so weak as to be like that?—No; I think it is much stronger than that.

4640. Do you consider that sewage is more adapted to a sandy soil than to other soils?—It is simply from the means of getting rid of the larger amount of water that you have in the sewage. I believe that if you put a moderate amount of sewage on a better description of soil you get a better result.

4641. You spoke, did you not, of the retention of the fertilising ingredients of the sewage by the constituent parts of the soil?—Yes.

4642. Did not Professor Way discover that property of the soil?—Yes.

4643. Did he not state that that was a power which was possessed only by clay soils, and other fertile soils of that nature?—To a great extent.

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4644. Did not he state in his evidence that a sandy soil had not that power?—Yes, he did.

4645. Then a sandy soil would not retain the fertilizing ingredients of the sewage to a great extent, but all the soluble matter would run through with the water; would that be so?—Not the whole, but a considerable amount of it would.

4646. Is it not stated that the water which drains from the Craigintinny meadows is very much coloured by the sewage, which is used there?—No doubt.

4647. With regard to the necessity of applying sewage day by day throughout the year, do you not know that Lord Essex applies sewage to different parts of his land every day?—No; I believe he applies it to a very small amount of his land.

4648. But he does not apply it all over his land every day; does he not apply it to one part to-day and to another part to-morrow, and so on?—Yes.

4649. Then the same land does not receive it day by day throughout the year?—Not day by day; but I have no doubt that he applies it very often to the same land, because he has abandoned a great deal of the land which he did apply it to.

4650. He utilises the whole of the sewage at Watford, does he not?—Yes.

4651. Might not the same thing be done elsewhere, so as to have the advantage of this increased area of land?—Wherever that has been tried it has been abandoned; Lord Essex has abandoned it, and Mr. Campbell of Rugby has abandoned it.

4652. Do you think that it is better to apply the sewage every day in the year to the same land?—In applying the sewage it must go somewhere every day; you must get rid of it.

4653. You are now speaking of getting rid of the sewage?—Lord Essex has undertaken to get rid of a certain amount of sewage every day.

4654. But with reference not to merely getting rid of the sewage, but to applying it beneficially to land, is it better to apply it every day on to the same land, or not to do so?—I can only answer that question by saying that it depends upon the proportion, upon how much sewage you apply to so much land. For instance, Lord Essex has, say, 365 acres under pipe; I do not quite understand whether the noble lord means that he ought to apply upon one acre one day's sewage, and upon another acre another day's sewage, and so on.

4655. You are aware that he does not apply the sewage to the whole of his land every day?—Only to a very small portion, and finds that it answers better than when he applied it to a much larger portion of land.

4656. He changes the portion of land that receives the sewage every day, does he not?—No; I think he has gone away from his arable land, where he receives it, to his park. If I recollect rightly, he stated that he had 300 or 400 acres under sewage, but that he found it better to put it upon 10 acres of rye-grass, and upon 30 or 40 acres of his park, but I do not understand him to say that those 30 or 40 acres are changed every year.

4657. You stated, in answer to the honourable Member for North Hampshire that you consider that irrigation is not of much value, and that it is more the solid portions of the sewage that fertilise the soil; is that your opinion?—Yes.

4658. Then, how was it you considered in 1862

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1862 that the sewage was of no value?—Comparatively of no value; that is to say, sewage produced smaller results in 1862 than in 1863.

4659. Why was that?—Because the season was cold; it was the fault of the temperature.

4660. Lord *Fermoy.*] Are the Committee to understand you to state that, if you had two acres of land, and if you had 6,000 tons of sewage, you would rather use the 6,000 tons of sewage on one acre only, than use it one week on one acre and the next week on the next acre, and so on through the year; that is to say, at the end of the year having applied 3,000 tons on each acre, shifting the application from one acre to the other alternatively?—If the sewage was delivered to me free of cost, I would rather have 3,000 tons on each acre.

4661. So as to allow one acre sometimes to be without any sewage at all?—Yes.

4662. Do you give that as your deliberate opinion?—Decidedly.

4663. You referred in the beginning of your evidence to some further results which you said you intended to publish; may I ask when you propose to publish them?—They are very nearly ready, I may say, now; there is a very large mass of figures, but the report is almost finished.

4664. You stated that you had tried sewage on Italian rye-grass, and on common pasture grass, and that you found that the common pasture grass gave, under sewage, as good results as the Italian rye grass; are you aware, as a practical farmer, that, without any artificial manure, or, at least, in the ordinary course of farming, Italian rye-grass does produce a much larger result than common pasture grass?—Yes.

4665. Then the inference from your evidence is, that sewage has raised the productive power of common pasture grass to the productive power of Italian rye-grass?—I give that result, but I gave an opinion with the result; that I believed that sewage would increase rye grass more than pasture grass, but my general opinion is that if you lay down pasture one year, you will have a longer production than you will have the next year.

4666. In fact, by the application of sewage, you can make pasture grass as good as rye-grass under certain circumstances; is that your view?—Give me an unlimited amount of sewage, and ask me what I think will produce the most, and I should certainly be of opinion that you could produce more pasture grass than Italian rye-grass per acre.

4667. However, you have not done so, have you?—The results have been exactly equal.

4668. Mr. *Ferrand.*] You stated, did you not, that the temperature in 1862 was so low that the sewage was of no value?—Comparatively speaking, that was the case. The sewage produced a large crop, but it had very little milk producing qualities.

4669. What sort of soil was that?—It was a heavy cold soil; the coldness arose from the amount of wet in the soil.

4670. Is there not less risk in applying sewage to a sandy soil at a low temperature than to a stiffer soil?—Probably that would be so, but still you would have better results from the stiffer soil.

4671. But the result would not be so injurious to the sandy soil as to the stiffer soil, would it?—No.

4672. Would you recommend in any scheme for carrying out the utilisation of the metropolitan sewage that it should be conveyed to a sandy soil rather than a stiff soil?—If you could find a sandy soil under the same circumstances it would be more desirable, but not from that cause alone.

4673. Sir *Joseph Paxton.*] A great deal has been said about the experiments made by Professor Way, taking specimens of the sewage in London from different places; would not almost every week in the year give you different results in that respect?—Yes.

4674. Do you know, with regard to London sewage, that it is carried off in three main arteries on the north side; those are the Lower Level Sewer, the Middle Level Sewer, and the High Level Sewer?—Yes.

4675. Is it within your knowledge that the High Level Sewer is to take off the storm water from the high lands, and that it conveys very little sewage; that the Middle Level Sewer takes the sewage down to Oxford-street and Holborn, and that the Low Level Sewer is going along the Thames Embankment. It would therefore follow, would it not, that the sewage in the Low Level Sewer would be much better than the sewage in the other two, on account of the denseness of the population, and the larger amount of sewage?—Yes, I should think so; certainly.

4676. Is it not the case, that you can never arrive at any accurate estimate of the London sewage until it gets to Barking Creek?—That is the great test.

4677. And when it gets to Barking Creek, and you have a daily examination of it, you will be able to test the accuracy of the results?—Yes; I am very anxious to test them.

4678. Supposing that you had the sewage delivered at your farm for nothing, how many tons would you use upon an acre, supposing the ground to be of the same nature as at Rugby; or how many tons would you use, supposing the ground to be a sandy soil; and how many tons would you use, supposing that you had to pay for it?—If I could have it for nothing, and put it on the ground, I would use 50,000, 60,000, or 70,000 tons per acre, or anything that you could give me.

4679. Would you do that upon the Rugby land?—Yes.

4680. What quantity would you use upon sandy land?—I would use the same quantity.

4681. But if you had to pay for it, what quantity would you use?—That depends on what I had to pay for it; the more I had to pay for it, the less I should use.

4682. Supposing that you had ¼ *d.* a ton to pay for it, how much should you use?—I think that then I should begin to use 4,000, or 5,000, or 6,000 tons an acre.

4683. If you had to pay ½ *d.* a ton for it, how much should you use?—Then I must begin to reduce the quantity. It is a question in my own mind whether I would give ½ *d.* a ton for it, and use 6,000 tons; but I cannot come to any exact nicety of opinion upon it.

4684. Will you give an approximation?—Of course the first thing would be that I should want a guarantee from the persons who sold me the sewage that they should deliver me a certain number of grains of fertilising matter per gallon.

4685. Supposing that that was all satisfactorily arranged, and that you paid ¼ *d.* per ton for the sewage, with all the proper ingredients in it, what

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quantity would you use per acre?—I think that then I should begin to use 5,000 or 6,000 tons.

4686. How many tons would you take at ½ *d.* a ton?—I should like to begin at 4,000 tons.

4687. At 1½ *d.* a ton what amount would you use?—It depends upon whether it is to be delivered to me on my land; and, when I see that it is to be delivered, the question is, whether I am to lay pipes down, and to use the hose; when you come to nice questions of cost I must calculate all those things.

4688. If you got 6,000 tons of sewage for nothing, would you expect to have hose put down for nothing?—That quantity I should use by irrigation; but when you come to small quantities you must use a hose, and that is very costly, and, therefore, it comes to questions of nicety in such small quantities.

4689. Then you would not use much at 1½ *d.* a ton?—No; not to take it all the year round.

4690. At 2 *d.* a ton how much would you use?—None at all.

4691. But you would give 2 *d.* a ton for it, if you could take it on certain days in the year, would you not?—Yes.

4692. Have you examined those Edinburgh meadows?—Yes.

4693. You have seen the result of the application of sewage there, and the great crops which they grow upon those meadows?—Yes.

4694. There the sewage passes through sand, does it not?—Yes.

4695. Is it not very clumsily done there?—Very clumsily.

4696. You stated that the water is discoloured as it leaves the meadows; but is not that owing to the slovenly manner in which a great deal of it is operated upon, rather than to the application of it in the form in which you might deal with the London sewage?—There is an enormous waste of fertilising matter, no doubt.

4697. But is it not making its escape directly, rather than indirectly?—If you could put the sea further off, and put another series of meadows below the present meadows, you would have an immensely better result, no doubt.

Jovis, 23° *die Junii*, 1864.

MEMBERS PRESENT:

Mr. Sclater-Booth.
Mr. Caird.
Mr. Ferrand.
Mr. Hibbert.
Mr. Leader.
Lord Robert Montagu.
Mr. North.
Sir Joseph Paxton.
Sir William Russell.
Mr. Tite.

LORD ROBERT MONTAGU, IN THE CHAIR.

Professor JOHN THOMAS WAY, called in; and Examined.

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4698. *Chairman.*] YOU are a Professor of Analytical Chemistry, are you not?—I am an Analytical Chemist.

4699. Are you Consulting Chemist to the Royal Agricultural Society?—I was for a great many years.

4700. You are now a member of the Sewage Commission, which was appointed in 1857?—Yes.

4701. Then, you are acquainted with the two Reports which have been published by that Commission?—Quite so.

4702. The case was mentioned to this Committee of a trial at Uxbridge, with regard to allowing the sewage to run into the river; and from the report of the judgment of Vice-Chancellor Wood it appeared that he rested chiefly on your evidence; for you stated that science had discovered no means of perfectly purifying water which had once been polluted by sewage; is that statement correct?—At this moment I cannot recal the circumstances exactly. I recollect something about the case; but it has never been brought before my attention since that time, and I was not aware that the decision of the Vice-Chancellor was founded upon my evidence. Of course it must be so if the Noble Lord states it; but if I stated that the sewage could not be perfectly purified by any known chemical means, I should repeat that statement.

4703. Do you consider that water which has once become polluted by sewage cannot be perfectly cleansed for drinking purposes, either by means of filtration, or precipitation, or deodorisation, or any other chemical process?—Certainly; it cannot be practically purified by any chemical process.

4704. All those means only diminish the evil, but do not remove it altogether; is that so?—They do not remove it altogether.

4705. Of course, then, you consider it a most objectionable thing that sewage should be allowed to flow into any rivers that are taken for the water supply of towns?—Whether the sewage be sewage proper, untreated sewage, or sewage in any other form, the evil may be very considerably diminished, so far as throwing the sewage of a town into a river is concerned, if the river be of considerable size.

4706. What I mean is this: the sewage of Oxford and of a great number of towns which are above London, in the catchment basin of the Thames, allow their sewage to flow into the river, do they not?—Yes.

4707. Of course it is very deleterious to the health of the people of London to drink that water, is it not?—Quite so.

4708. And filtration does not perfectly remove the evil?—No.

4709. If sewage is not to be allowed to run into rivers, and if all those means of precipitation, filtration, and deodorization are ineffective, what other alternative is there for dealing with the sewage?—To use it in a liquid form upon land.

4710. That is, in fact, the only other alternative, is it not?—Yes.

4711. You agree with all the other witnesses who have already stated that to be the fact?—I fancy that my experiments upon that subject are the basis of the opinions of most of those witnesses.

4712. Is it your opinion that the liquid form is the only form in which sewage can be well applied to land?—It is the only proper form of dealing with sewage, there is no doubt.

4713. In the first Report of the Commission, at pages 32, 40, 41, and 43, they state that the sewage is increased in value during a storm, is that the case?—I do not think that the Report states that the value is increased; it says that there is a larger quantity of solid matter brought down during rain, but I think it does not say that the value is increased.

4714. Do you think that the value is not increased by that amount of solid matter being brought down?—Certainly not; it is the comparatively worthless part of the sewage. That Report seems to me to state that the liquid being perfectly free from solid matter, or comparatively free from solid matter, is not found to be so valuable for irrigation. It says, "It has been stated how little solid matter is conveyed in this stream. No where in appearance is it as muddy as the Thames between the bridges, and yet much of the land irrigated by it becomes so rich that the surface is pared off every few years, not as erroneously stated by some writers on the subject, in order to preserve the level of the lands for irrigation, but to obtain the vegetable matter which becomes in time

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time too luxuriant in growth, as material for manure for other lands, for which it is highly prized." That refers to the case of Milan, but I think that that is not intended to convey the notion that the solid part of the sewage is the most valuable.

4715. You do not agree with Messrs. Hofmann and Witt, who state that the sewage is richer during heavy storms than at other times?—I am not aware whether they state that it is richer; they state that it contains a larger amount of solid matter, but I do not think that they state that it is of more value.

4716. Do they not state that it contains more matter in suspension?—That is the least valuable part of the sewage. You will find that Messrs. Hofmann and Witt, like every other chemist, would place the greatest value upon the liquid parts of the sewage.

4717. The matter which is contained in the storm-overflow, is the matter that is washed from the streets, is it not?—No doubt there is a good deal of that.

4718. Has not that great fertilizing value?—It has a large quantity of potash generally, especially after a drought of any kind.

4719. In the Report of the Metropolitan Drainage, at page 20, it is stated that, "Professor Way has analyzed samples of street waters intercepted in their passage to the sewers, and states that it would be as valuable in a manuring point of view, as the ordinary contents of the sewers;" is that correct?—Quite so; it is potash, principally, that it contains.

4720. If there are more of those matters in the storm-overflow, is the sewage at those times, in fact, quite as rich, if not richer, in manurial matter than the ordinary sewage flow?—It is richer in one sense: in the fact that it contains potash; but on the other hand, the value of any other substances is very small.

4721. You alluded, just now, to the application of sewage at Milan, which is so excessively weak; is it not stated in your Report, that although the sewage is so weak, the lands are raised in value by 4 *l.* or 5 *l.* an acre?—Yes, I believe that that is so. The Report says, "In the case of Milan, where, although the water used for irrigation receives little or nothing of the solid excrement of the population, and is so dilute that it is hardly to be distinguished by the senses from ordinary stream water, it confers upon the land to which it is applied an increased value of from 4 *l.* to 5 *l.* per statute acre per annum above that obtained for land irrigated by streams containing no sewage."

4722. Does not that show that sewage, although it be very weak, is still exceedingly valuable for the land?—Quite so. At Milan it is put on in very enormous quantities, because the sewage of Milan, so far as there is any sewage flowing at all, flows into the streams, and the whole streams are at command.

4723. Do you consider that sewage irrigation is bad for health?—It depends very much upon the conditions under which it is carried out. As a matter of course, if there are very large quantities of sewage, people will complain, as in the neighbourhood of Edinburgh, of the offensiveness of it; but we found that in that case the offensiveness was more due to the open gutters than to the sewage itself.

4724. The actual irrigation of sewage itself is not bad for the health, is it?—No, I believe not.

4725. And no offensive smell proceeds from it?—Not if it is properly put on.

4726. Is it necessary that sewage water, if applied to land, should be deodorised?—No; it is a mistake to do so.

4727. You were, I believe, the discoverer of the fact that land possesses the power to deodorise the sewage, and that it is, in fact, the most powerful deodoriser known; is not that the case?—Yes.

4728. You stated in your evidence before the Committee on the Sewage of Towns in 1862, that soils contain a power to separate from liquids containing manure all the important elements of the manure, and that that action takes place, not by mere filtration, because those dissolved matters would pass through a filter, but by a sort of chemical attraction, between the ingredients of a fertile soil and those of manure?—Yes. At this moment there is a dispute as to what the nature of that action is; Baron Liebig believes that it is a physical action, similar to the action of charcoal, in removing colouring matter from syrups and things of that kind; my own conviction is, that it is a true chemical action; but it is not at all a settled question.

4729. It is an attraction between the clay and the manurial property of the sewage, is it not?—Yes, in a great measure.

4730. Then would not that action be very much diminished, if it exists at all, in a sandy soil?—A different action is set up in a sandy soil, which is very much inferior in its effects in the retention of the materials of manure.

4731. In fact, a sandy soil is more like a filter, is it not?—Yes, it is; but there is a peculiar action of sandy soils which is of a different nature, and very much less in degree, but which is still not without its effect.

4732. The moment the sewage has sunk into a clay or loamy soil, does not the smell disappear?—Yes.

4733. Is that because those manurial properties have all been abstracted by means of the soil?—Yes.

4734. And the sewage water which has already percolated through such a soil comes out in a perfectly pure state, unless the dressing has been immoderately great?—I will not say that it is absolutely pure; it is not so pure, perhaps, as spring water; but it is free from any offensive character, and in many cases it is beautifully bright.

4735. That power in the soil has its limit, has it not?—Yes.

4736. And when you have reached that limit, the sewage would pass through and reappear in an impure state, would it not?—Yes; speaking of a soil, without reference to the vegetation, and looking to the mere action of the sewage.

4737. Have the roots of plants a similar power in extracting the fertilising qualities from the sewage?—They can only do so according to the rate of their growth.

4738. They merely take it up and assimilate it?—Yes; they have no power similar to that of soils.

4739. If the whole body of the London sewage ran on to 30,000 acres of sand, would not the fertilising matter escape through it as it would through a filter?—It depends upon the depth of the sand, and upon the quantity of sand that it would have to penetrate; it is a question of surface quantity, and not of a superficial quantity.

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4740. It is merely a filtration, is it not?—Not actually the filtration; speaking of sand apart from vegetation growing on the sand, the sand has a peculiar power, which is totally different from the power which clay possesses, of which we were speaking just now, but which is still a specific power of its own, of absolutely separating salts up to a certain point from solution. Very old observations have been made by Dr. Hale and other philosophers, 200 or 300 years ago, in which the filtration of salt water, for instance, through pots of sand, was found would give water free from salt at all. I do not mean to say, that, practically, it is of any importance, but according to the quantity of sand, it would be of importance.

4741. It is stated in the report on the River Thames, that water deodorised by chemical agents, if kept in a tank, would stink again; do you concur in that opinion?—Quite so.

4742. Precipitation, you say, is also a failure? —Economically it is.

4743. Is it also a failure to purify the liquid? —To purify it for use as water for drinking purposes, it is a failure; but I am not so sure that where a quantity of sewage is to be thrown into a large bulk of water, the precipitate would not accomplish the sanitary object to a great extent.

4744. Would it be a failure, so far as regards keeping the air pure?—It would improve the water for drinking purposes very largely; for instance, the sewage of Oxford is thrown into the Thames, and many of the water companies draw their supplies of water from the river above Teddingdon Lock, and therefore it has all the sewage of the towns above Teddington.

4745. It would not cure it entirely?—Not entirely; but it is a question of degree. My opinion is, that the precipitation of the sewage at the various towns, Reading, Oxford, and all those places lying above Teddington, would very greatly improve the Thames water for the London population, although I do not say it would entirely, theoretically, free it from impurities.

4746. Are you speaking of precipitation with lime?—With the various agents that are used, such as lime, or chloride of iron.

4747. Would not the chloride of iron be injurious?—You would never have chloride of iron left in excess in the liquid.

4748. Would the lime be injurious?—No.

4749. The manufacture of dry manure from sewage has been found to be a failure, has it not? —Yes; I am very happy to say that nobody advocates it at this moment.

4750. It cannot be produced at a profit?—No.

4751. The supernatant water, which is left after precipitation, is injurious to the health, is it not? It is, if it is not mixed with a large bulk of water; in fact it contains the principal valuable materials of the manure.

4752. Does lime neutralise those matters that are contained in solution in the sewage, or does it only precipitate those that are in suspension?—That is all; it acts like white of egg in clearing coffee.

4753. Did you not state, before the Committee of 1862, that nine-tenths of the manurial value of the sewage remained in the liquid after precipitation?—Yes.

4754. Then we come to this again; if sewage may not be put into rivers because of the health of the population, and if filtration, precipitation, and deodorization are all failures, we are absolutely constrained to put it upon the land by means of irrigation, as there is no other course left open to us?—I think that that is the proper thing to do with it.

4755. When we sell off our lands, the cattle that have been fed on them, and the corn and other substances that have been grown on them, we, in fact, are removing from the land certain constituents of the soil that are necessary for the growth of the plants?—Yes.

4756. But, unless those constituents are in proper proportion, nothing will grow, and if they exceed that proportion the soil is called very fertile, is that so?—I think that what Baron Liebig states on that subject is perfectly true, namely, that the smaller of the ingredients present, to a great extent regulate the growth on the surface of the land; that is to say, that if there be several substances in large excess, and one that is deficient, the growth will be in reference to the one that is deficient, and not to those that are in large excess; but where there is an abundance of certain substances, such as the mineral substances, phosphoric acid, and potash, and so on, the existence, in large quantities, of ammonia, for instance, will produce a very large increase of growth, and really an excessive growth.

4757. In fact, is the object of putting artificial manure upon a soil, to return to the soil those things that we have taken out of it in the shape of plants, and the flesh of cattle, and so forth?—That is one great object, but practically it is found that artificial manures, especially superphosphate of lime, for instance, when put on the land, increases the fertility of the land. Supposing that it had been put on last year, its being put on this year would give you a much larger crop than you would get without it, although you would find that you had not taken out all that you put on last year.

4758. Does it enable the plants to assimilate other substances with greater ease?—Yes.

4759. Is it not the case that a farm cannot be self-supporting so long as the corn and other matters are all sold off the farm?—Yes.

4760. In proportion to the supply of artificial manure, is not the farmer enabled to grow greater crops?—Yes; a judicious farmer may grow pretty well what crops he likes if he has an abundance of manure.

4761. Then, if he has an abundance of manure, he could, in fact, afford to pay a higher rent for his land?—Yes; but then there is the question whether or not he is to pay for the manure. If you give me any quantity, and put me on the free list of manure, so to speak, so that I might have as large a supply of manure as I liked, I could make a very different thing of almost any land that you could give me.

4762. But supposing that a farmer has an unlimited supply of manure, he would be able to grow much larger crops, and, therefore, having the larger crops and the same extent of land, he would be able to pay a higher rent; is not that so?—Quite so; in fact, in giving him manure, you have given him the wherewithal to pay a higher rent.

4763. Therefore, would not both the landowner and the occupier be benefited by the increased amount of manure?—Certainly.

4764. If, in addition to the amount of manures which are used in the country being increased, the price of them were reduced, the farmer would be able to grow his increased crops with a larger margin of profit, would he not?—Yes.

4765. And, therefore, even in that case, he could afford to pay a higher rent?—Yes.

4766. Therefore, it is the interest, if I understand you, of both the farmer and the landowner to secure an increased amount of manure and a reduction in its price?—There is no doubt in the world that the supply of manure is miserably insufficient for an improved state of agriculture; that is to say, supposing that 99 farmers were to farm as the one-hundredth does at this moment, there would be a scramble for manures.

4767. There is a report, which has been sent to this Committee from Paris, which was made by M. Béhic to the Emperor, in which he states that the amount of manure used in France is 223,000,000 tons, and is worth about 20,000,000 *l.* sterling; can you tell us the amount that is used in this kingdom; is it as much as that?—I have not seen that report; does that refer to artificial manures?

4768. It refers to every kind of manure?—That does not include the manure of the farms, because that would make a vast difference to it.

4769. Do you know what is about the amount that is used in this country?—I have calculated it once or twice, but any calculation would be a mere approximation, because we have no means of checking the private manufacturers.

4770. You could not state whether the amount of artificial manures which is used in this country is more or less than that?—I should say that it was very much less than that; I cannot understand how such a large sum as 20,000,000 *l.* should be arrived at.

4771. It does not take in farm-yard manure, but it includes guano, urinated-lime, human fæces, offal, bones, horse-flesh from the knackers' yard, woollen rags, oakum, sugar refiners' and distillers' refuse, cinders and charcoal, wood ashes, fish manure, and seaweed; do you think that such manures would amount to 223,000,000 tons in this country?—I should not have expected that they would amount to anything like that, but I should say that it is not anything like that in England, where, no doubt, we use a great deal more artificial manure than they do in France.

4772. Can you state, in round numbers, the amount of guano which is sold in the British Islands?—I should think from 150,000 to 250,000 tons.

4773. What is the price of that per ton?—£. 13.

4774. And what is the amount of superphosphate, including bones?—It is very difficult to ascertain that, but I should say that it might be from 150,000 to 200,000 tons in a year.

4775. What is the price of superphosphate per ton?—It averages about 7 *l.* per ton.

4776. I see that there is a Fish Guano Company started, and that you are one of the directors, and that Mr. Morton, editor of the "Encyclopædia of Agriculture," is another; is that manure very extensively used?—That company is defunct.

4777. Then you do not count this fish manure as guano?—No; besides, it would have been a very small thing in the manure history of the country, if it had succeeded.

4778. Is nitrate of soda used as an artificial manure to a great extent.?—Yes, it is used to a great extent, but it is nothing in comparison to guano; it is a substitute for the ammonia of guano, and it has very much the same effect.

4779. Then, in fact, the plant decomposes this nitrate of soda and turns the nitric acid into ammonia with the help of water?—Yes, and in some cases it is really as valuable as ammonia. I do not wish to depreciate it; it is exceedingly valuable as a manure, but when you come to the question of the many importations, and the use of manure in this country, I should say that the amount of nitrate of soda was comparatively small; if you said that it was 25,000 or 30,000 tons in the year, I should think that would be quite the outside.

4780. What is the price of it per ton?—I think that nitrate of soda is about 16 *l.* or 18 *l.* per ton.

4781. Is there any other kind of guano used which you have not already estimated for, or do you include that in the guano you have already referred to?—There is Sombrero guano.

4782. How much of that is used per year?—Perhaps 15,000 tons, I should think, but it may be more.

4783. Is the price of that the same as the price of the other guano?—No, it is never used directly as a manure; it is used for making superphosphate, or, at least, I believe that is so generally, but I am not quite sure.

4784. What is the price of that per ton?—I think it is about 6 *l.* My quantity of 200,000 tons, would cover all the manures of the nature of superphosphate.

4785. If sewage were to be extensively available as a manure, the total amount of manure would be increased, and the price of the artificial manures would be decreased, would it not?—It would prevent the price from going up. My own impression is that if some fresh new sources of manure are not obtained, as chemical and agricultural knowledge and information are distributed with regard to manures, the prices of the manures will go up.

4786. Is that because the supply of artificial manure is very restricted, and at present too small?—Yes.

4787. But otherwise sewage and artificial manures would be rivals; they would be competitors in the market, would they not?—Yes, but I meant to say that there is so open a market for manures that there would be no rivalry, and I am afraid that it would not be followed by a diminution of price.

4788. It would prevent the price of artificial manure going up, would it not?—That may be so.

4789. Would it be the interest of the artificial manure trade, as a class, that sewage should not be utilised, so that they might retain in their own hands the supply of all the manure in the country, without any rival?—I think not; I think that is quite a mistaken notion; I cannot see how a manure dealer, if he is a man who understands what his interests are, can fancy that he would gain anything by suppressing the use of sewage, as of course it could not, by any possibility, go any very great distance from towns. In the case of London, it could not go beyond about 20 miles from London, and nobody would propose that it should; that is to say, unless it is to be applied to a very large area of land, such as several hundred thousand acres.

4790. The sewage would be utilized in the neighbourhood of towns where artificial manures are not used, and then artificial manures would be taken down by railway and utilized at a greater distance

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distance from the towns than the sewage could be conveyed to; is not that your view?—Yes, because at this moment a town receives its commissariat at a certain distance, according to its size, from its centre. London, we may say, receives all its vegetables and that kind of thing from within 20 miles, perhaps; and the carts that bring in the produce into London take out the stable manure, in a solid state; and I should say that not one-fiftieth part of the artificial manures which are sold by manure dealers are sold within the area to which the sewage would be applied, even on the most extravagant ideas as to the area.

4791. Why were the experiments of the Commission intrusted to Mr. Lawes; was it because of his knowledge of artificial manures, or for what reason?—Not so much from his knowledge of artificial manures, but that he has all the means, in the shape of a properly arranged staff of officers, and he has all the experience necessary for the carrying on of experiments in agriculture generally.

4792. He has taken a vast deal of trouble to carry on the experiments for the Commissioners during three years, and neither he nor the officers under him have received any remuneration whatever, have they?—No; but there is one great peculiarity in Mr. Lawes's career, which is this, that for a great many years he spent a large sum of money annually in making agricultural experiments; and, on the whole, I believe that those experiments, although he has freely reported them to the public, have not been in favour of his trade and position as a manure merchant, but rather on the contrary.

4793. Do you mean previously to the nomination of this Commission?—Yes, years ago; he has been engaged in those experiments for the last 23 years. In point of fact, Mr. Lawes makes principally superphosphate of lime; and, except for root crops, he has found that superphosphate of lime is of very little use; consequently, if he were seeking his own interest as a manure dealer, he had better have left those experiments alone.

4794. Does not he sell guano also?—Very little; he does not care to sell guano.

4795. With regard to the experiments at Rugby, in general terms, the results have been, that he and those under him have recommended that sewage should be applied in very large quantities; is not that the case?—Yes.

4796. Mr. Lawes stated to the Committee the other day, that he never tried any application of sewage to a less amount than 3,000 tons an acre; is not that the case?—I am not quite sure, but I fancy he has used less than that.

4797. I understood from him that he had not made an experiment with a smaller amount than 3,000 tons per acre?—I think he has done so, but I am not quite sure.

4798. In the abstract, apart from the expense of the works necessary for delivering the sewage, would you not get a larger return in the shape of crops by putting the sewage over a larger area than a small area?—Yes; I have always said that to get the full value of sewage, quite irrespective of economical considerations, you should put it on so that none runs off.

4799. For instance, in the case of dry manures, although it would be more expensive to cart those manures over a large area than over a small area, yet the farmer would not obtain a sufficiently increased return over the small area to enable him to pay for the manure; is that so?—Yes.

4800. So that you must calculate what extent it would require to enable you to pay for the manure, and then apply it to as large an area as you can?—Yes; but the carting of artificial manures is a very different thing from the carting of farm-yard manure, because the expense is small comparatively.

4801. You mean that it is less bulky?—Yes; 2 cwt. of artificial manure is equal to 20 tons of farm-yard manure, so far as its special application is concerned.

4802. But still the same rule would apply, would it not, that you take into consideration the price of carting in calculating the proper area for application?—I do not think a farmer does that in the case of artificial manures. He says I get so much more crops by using 3 cwt. of guano or superphosphate of lime than by using a very much larger quantity of other manure, and, therefore, I use that quantity.

4803. In fact, it is a sort of balance between the purely engineering question of erecting works to deliver the sewage and of the return that you would get from increased crops, and your area is to be determined accordingly?—Yes; that is so.

4804. Mr. Lawes stated in his evidence the other day, and also before the Committee of 1862, that he was never able, with an enormous quantity of dry manure, to obtain more than 12 tons of grass per acre; are you aware of that?—Yes.

4805. But, according to the Return contained in the second report of the Commission, it appears that he has got more than 32 tons per acre by means of sewage?—Yes.

4806. From a Question (No. 940) which you answered in 1862, which was asked by Mr. Ayrton, and again from the answer to the Question 777, it would appear that you think that, in order to get the greatest return in proportion to the amount of sewage, it is necessary not to apply it too prodigally to the land, but that you must act in the same way with sewage as you would with any other manure; is that your opinion?—I have just now stated that there are two ways of viewing the question, and they must be very carefully separated in appreciating the drift of my answers. The first is the question of really getting the largest produce from a given quantity of sewage, irrespective of expense; that is not as an economical or practical question, but what would theoretically and in fact, if you disregarded expense, give the largest return. The other question is, what is practicable and reasonable so far as expense is concerned. I have no hesitation in saying that the way of dealing with sewage, regardless of expense, so as to get the greatest amount of value out of it, would be to put it on in small quantities. Therefore, if it could be shown that it was worth while to put it on in small quantities, that would be the most economical way of dealing with it; but it comes entirely to a question of expense.

4807. You must balance the engineering question of the price of the works against the probable return from the sewage?—Quite so; you must put sewage on the land, so that no portion should run away at all. In that case, you would have the whole of the salts of the sewage fixed in the soil; there would then be no loss, and you would get the greatest value from it. On the other hand,

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hand, when you put on such very large doses as 3,000 tons, the water runs off, containing a great deal of the value of the sewage with it; but that is as I say, a practical question—a question of expense.

4808. Is not the colour of the sewage water due to the matters which are held in suspension?—Not altogether; it is coloured even if you filter it.

4809. Then it is coloured, also, by matter in solution, is it?—Yes.

4810. But not to a very great extent?—Not very much.

4811. The colouring matter is chiefly due to the matters which are held in suspension, is it not?—Yes; the foul looking condition of the sewage is due to that.

4812. The matters in suspension contain only one-seventh of the manurial properties compared to what is contained by those held in solution, I believe?—That is much about the case.

4813. If the water, in escaping from the drains, appears to be pure, it would not follow that that water did not contain some of the fertilising matters in solution?—Not at all.

4814. But if the water which issued from the drains contained colouring matter, then, *à fortiori*, it must contain some of the fertilising matters in solution?—Quite so.

4815. Then, in that case, there is a waste of manure, is there not?—Yes.

4816. The soil has not been able to take all the fertilising matters from such a body of sewage, and retain them?—No; that power has its limits.

4817. In fact, if we see the water escaping in a coloured condition, does that circumstance show that we have been applying too much sewage, and wasting it?—We have been applying too much sewage to get the whole benefit out of it, but whether we have been practically wasting it is another question.

4818. Did you not make an analysis of two specimens of sewage, one the Dorset-square sewage, which is the poorest, and another the Barrett's-court sewage, which is richer?—Yes.

4819. In 10,000 gallons of the poorest sewage, you found that the ammonia and insoluble phosphate of lime alone were equal to 13 *s.* 6 *d.* in value; is not that the case?—I am not sure that I calculated it at 13 *s.* 6 *d.*, but I have no doubt that that value is correct.

4820. That calculation does not take account of the other fertilising ingredients, does it?—No.

4821. Two hundred and twenty gallons being a ton, 10,000 gallons would be 45 tons?—Yes.

4822. So that the amount of phosphate of lime and ammonia in a ton of sewage would be worth $3\frac{6}{10}$ *d.*?—224 gallons make a ton, and if you take it at 225, it is a little more than 40 tons, or about 43 tons.

4823. That would give you the value of the ammonia and phosphate of lime in each ton as being equal to $3\frac{6}{10}$ *d.*, would it not?—I am taking those figures for granted, because those are not my calculations, but they are calculations upon my figures.

4824. The Barrett's-court sewage contains twice as much of the ammonia and phosphate of lime, does it not?—Yes.

4825. Then the amount of those substances in the Barrett's-court sewage would be valued at 7·2 *d.* in each ton, would it not?—That I have not calculated. I remember perfectly well that I only took the lowest one, but that has been calculated by Mr. Hughes in this paper, and no doubt it is correct.

4826. Messrs. Hofmann and Witt give the value of the phosphates, potash, and organic matters; in fact, of all the fertilising matters in a ton of Dorset-square sewage as equal to 4·7 *d.*, do they not?—I heard that question asked of Mr. Lawes at the last examination, and there was a little misconception about it. Messrs. Hofmann and Witt give the data for calculating, and if I am not much mistaken, Mr. Hughes has taken those data and calculated them; that is to say, Messrs. Hofmann and Witt have not analysed that sewage at all; it is not a fresh analysis, and it goes on the assumption that that analysis is a correct analysis. The calculations of Dr. Voelcker and Messrs. Hofmann and Witt are made on the same analyses. It is merely a question of the prices attached to the value of the particular ingredients; it must not be supposed to be a confirmation of that analysis.

4827. It is merely putting a value upon the different ingredients which are contained in a ton of sewage, according to your analysis?—Quite so; therefore, to take their price as correct, you must take my analysis as correct.

4828. Then, if your analysis be correct, according to their valuation of the materials, a ton of sewage would contain fertilising matter to the value of 4·7 *d.*, would it not?—Yes, that is so.

4829. According to Professor Voelcker's valuation of those materials, a ton of sewage would contain 4·6 *d.* of fertilising matter, would it not?—Yes.

4830. According to Professor Voelcker's valuation, a ton of Barrett's-court sewage would contain 1 *s.* worth of those materials?—Yes; I have no doubt that that is correct.

4831. And according to Messrs. Hofmann and Witt's valuation, they would give 12·3 *d.* as the value of the fertilising materials in each ton of Barrett's-court sewage?—I should say that Messrs. Hofmann and Witt adopted my figures, not my analysis, but my figures for the value of the ingredients; those were very carefully gone into some years ago, taking the value in the market of the different sorts of manure, and attaching to each individual ingredient of the manure a certain value; Messrs. Hofmann and Witt, therefore, have adopted my figures, and would have come to precisely the same result as I have; the only difference is, that Mr. Hughes has put down other substances as existing which I have not put down.

4832. In what year was that analysis made?—I cannot very well tell you, but it was previous to 1850. I hope the Committee will not consider it improper if I make some remarks with regard to these analyses; these analyses of mine have been continually used in this discussion, in spite of the fact that I have over and over again repudiated the analyses as indicating at all the value of the London sewage. Those samples were taken, I think, under the authority of the Board of Health, Mr. Chadwick being then the Chairman of the Board of Health; he might have suggested himself that I should get some samples; however, the officers of the Board of Health were employed in collecting those samples; they were collected from two places, which, as you observe, are not outfalls of sewers at all, that is to say they were dipped out of the man hole in Dorset-square and a place called Barrett-court, near Oxford-street.

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At that time you will find that there were reports over and over again from engineers, (not being confined to the engineers of the Board of Health) in which they state that a collection of the sewage takes place in some of the sewers, especially where the water supply is deficient in which the sewage goes on fermenting for weeks and months without change, but a flood comes and sweeps it all away, or they have to flush the sewers with water, or sometimes to dig out the masses. At the time that these analyses were made, no other analysis had ever been made, and I regret now very much that I published them; I regret it because they have been used for advocating a view in which I do not at all coincide. I do not believe that the sewage of London is of anything like the value that has been calculated from them. I have over and over again repudiated those analyses, and at the very time when they were published, I made this remark at the end, "The calculations here given must be looked upon, as we have before said, merely as an expression of the great agricultural value of the sewer water of towns, and not as an attempt to fix that value with any approximation, even to the truth."

4833. Would you state why you consider that the value of the London sewage is not equal to what you have stated there?—In the first place, in our second report of the Commission to the Treasury, you will find at page 69 a report made by myself; we made some experiments on the processes for precipitation, with a view of setting at rest the question of the value of the manure precipitated by different chemical substances. For that purpose we collected the sewage water of the Northumberland sewer, and there are three different analyses of that sewage water reported here which were very carefully made, I should say certainly quite as carefully as those that were originally made, and probably more satisfactorily so, because 10 or 12 years had elapsed since the first ones were made. You will find that the quantity of ammonia on the 2d of March 1859, from the Northumberland sewer at 3. 30 in the afternoon, was 7·48 grains to the gallon, that is as against the Dorset-square sewage, where there were 17·96 grains to the gallon; that is, in point of fact a great deal less than one-half.

4834. Will you explain the meaning of these three columns to which you have directed our attention: "grains per gallon before treatment," "after treatment," and "precipitated"?—This is, as you see, an examination into the processes of precipitation. This is a precipitation by lime. "Before treatment" means the contents of the Northumberland sewer, analysed just as we had taken it out of the sewer; "After treatment" means after we had added to it the lime.

4835. Is that before you had extracted the precipitate?—No. Here is the composition of the water after dealing with the lime, and here also is the composition of the substance precipitated.

4836. If we add the precipitate to the water after treatment, it ought to give us as the result the first column, ought it not?—I think not.

4837. It appears that if we add the total of the column "after treatment," and the total of the column of the precipitate together, that should give the first column, but the figures do not agree; can you explain that?—I should think that this precipitate really means the percentage composition; but I cannot explain that at this moment. On page 70 there is a similar analysis of the sewage which was collected on the 12th of April (the other being collected on the 2nd of March), and there again the ammonia is 8·43 grains per gallon. On page 71 there is another similar analysis, collected on the 24th of March, all at different periods, and that was 7·88 grains per gallon. Now, I have always said that I would not take the analysis of any moderate number of samples of the sewage of London as an indication of its composition. In a paper which I published on town sewage a great many years ago (in 1854), I said that the London sewage would differ at every great outfall; that it would depend upon the nature of the population and upon the nature of the roads, and upon whether water-closets were freely in use in any particular district or not; and that no one sample from one sewer, or even a number of samples from one sewer, would give you a fair indication of what the whole of the London sewage would be, and that it was only when the sewage of London came to be collected together at one outfall that you would have any chance of forming a knowledge of its value. I think I can point out to the Committee that I have said so, and I think I have a fair right to complain that the analyses which were made by me 14 years ago, and which I have repudiated, have been used as the basis of all these calculations. They were perfectly correct so far as they went, but with the greater knowledge that we have obtained, we know that they do not represent the actual state of things; and I do not feel it any discredit to myself that those analyses should not represent the actual state of things, especially as I have been exceedingly cautious to guard against their being used for that purpose; but surely my later analyses ought to be used in preference to those earlier ones?

4838. Have you analysed the sewage at the general outfall at Barking Creek?—No.

4839. That has never been analysed by anybody, has it?—I suppose not.

4840. In this Table, at page 69 in the Second Report, it appears the sewage was taken from the sewer at 3.30; is it not the case that two-thirds of the volume of the sewage of London flows in the first eight hours of the day?—I should fancy it would be so in the case of a small town, but hardly in the case of London. The Northumberland Sewer, I suppose, drains a very large area.

4841. You are aware that it is stated, in the report on the metropolitan drainage by Messrs. Hofmann and Witt, and also by some of the witnesses who have appeared before this Committee, that two-thirds of the volume of the sewage runs in the first eight hours; do you think that that is not the case?—I do not say that at all; I know it is the case in small towns, but here, on the other hand, you will see that the second sample is taken at 3 o'clock, and that the third is taken at 9.30 a.m., which is really the time at which it is supposed that it is richest.

4842. Mr. *Caird.*] What is the quantity of ammonia contained in the sewage at that time?—Much the same as the other two; but I wish to put it on record that I do not believe that any analyses of London sewage have given any approximation to its value, and I have the strongest conviction that those analyses which have been quoted, from Dorset-square and Barrett's-court, are entirely unfit to be relied upon as proving the value of the London sewage.

4843. *Chairman.*] Then do you think that it ought to be tested by analysis when it arrives at Barking Creek?—It must be determined by analysis, in the first instance, no doubt; but then I go further than that, and I say that when you have the value of the ingredients by analysis, I by no means say that you have the value of the sewage practically for farming operations.

4844. That must be tested by experiment alone, must it not?—That is the only way of doing it.

4845. Mr. *Tite.*] With regard to the experiments which you have adverted to, and about which the Noble Chairman has examined you: as to the inquiry into the quantity of ammonia contained in sewage water, that inquiry simply had reference to the quantity of lime required to precipitate it, though, in the first instance, the analysis shewed that the quantity of ammonia was as 7 against 17?—Quite so; the analysis of the sewage water was necessary before one could see what happened in treating it.

4846. After the lime had been added to it, then you ascertained, also, what amount of ammonia was left?—Quite so.

4847. Therefore, merely adding the two figures together, it would not follow that you should obtain the number in the first column?—I cannot at this moment explain how that is, but that was an analysis of the water. The quantity would be altered by the lime.

4848. Did you ever make any analysis of the water at Rugby?—We had 93 separate analyses of that water.

4849. What quantity of ammonia was there in that?—The average of the 93 analyses, I think, is 6·4.

4850. It is then 6½?—Yes; but it is a little higher. If you club all the analyses together, and take the average of them, it comes to that; but that is hardly fair, for this reason, that there have been more analyses taken in some months than in others, and it is a little higher than that; it is about 7½.

4851. You have stated, have you not, that if the sewage water is used in small quantities, and over any area, regardless of the expense of distributing it, it would be most productive?—Yes.

4852. Will you explain in what way you suppose that to be done, without reference to expense? —I should put it on with pipes and hose, almost as I would in garden cultivation, as if I were watering it with watering-pots.

4853. Do you think that that is the best mode of applying it?—I do not say so for a moment; I am merely speaking now of the theoretical question, in contradistinction to the practical and sensible question.

4854. So that if we are to get the most value from the sewage, irrespective of expense, we should put it on in small quantities, so that it may dry up in the soil?—Yes.

4855. And it should be applied with the hose? —Yes; but I am not advocating that system of application at all.

4856. In fact, as Mr. Mechi distributes it; have you seen that process?—Yes, I have seen it often.

4857. Is that the mode which you would prefer, if you had the choice?—No. I beg that I may not be misunderstood in that matter; I say that, on the one hand, in using large quantities of sewage you undoubtedly carry away from the land a quantity of valuable matter. My present belief is that that is a necessity of the case, and that you cannot do otherwise; but if you ask me how I am to make, regardless of cost, the manurial ingredients of the sewage into the greatest amount of produce of any kind, I say that it will be done by putting it on in small quantities, but it would never pay to do it.

4858. Take the case of the Metropolitan Board of Works: the sewage is poured, in enormous quantities, into the reservoir, and it is to be distributed on the land in some way or other; have you ever considered the question how that is to be done?—It cannot be done, I think, by putting it on with a hose and jet, because you would never get the quantities on that it would pay you to put it on.

4859. Taking into account this fact, that the farmer must take the sewage whether he wants it or not, would that be advantageous, or otherwise?—He could not do it; if he is bound to take large quantities at any time, he would soon decline to take it.

4860. Because his land would soon become flooded?—He could not do it in times of rain, like June, or July, or October.

4861. Then, practically, how are we to deal with it; are we to let it go into the river, as before, at such seasons, or is the farmer to be expected to take it?—My belief is, that if it be put on land expressly prepared for it, it would be taken at all times; in fact, that is a necessity.

4862. What quantity of land would you require for that purpose, and what preparations would be necessary?—It must be laid out expressly for irrigation with sewage.

4863. Must it be a particular soil, or may it be taken accidentally?—The noble Chairman asked me just now whether the power of removing manures from liquid did not rest with a clay soil; undoubtedly it does, but a dry and absolute clay soil would be about the last soil that I would wish to use sewage upon, because, although it possesses the power of abstracting the manurial quantities of the sewage, the sewage cannot get into it; it is physically unfit for the purpose. But a soil containing a certain quantity of clay, but which is otherwise very open, would be the one that I should prefer to use; I would prefer, of course, a half-and-half kind of soil, such as light loam, to any other soil.

4864. Would it make any difference if the stiff clay were deep-drained?—It would not get through in large quantities; it would simply run over.

4865. We shall have to deal with the excreta of 3,000,000 people in the two outfalls; and it has been stated to the Committee that to utilise that sewage you ought to have 30,000 acres of land, which is giving, of course, the excreta of 100 people per acre; is it your opinion that you would require that quantity of excreta of 100 persons, diluted as it would be by sewage water, for an acre of land?—You could with advantage use it.

4866. Then, if you would have your choice, would you have 30,000 acres of fit and proper land adapted for the purpose, to apply the sewage of 3,000,000 people upon?—I think you might take a larger area; but that quantity of land would take it, provided that it was all grass land.

4867. Can you give any limit to the larger area, taking the most desirable mode of applying the sewage?—I would prefer rather a larger area, because if the sewage comes down to one special point, which must be some distance from London, the only way in which you can deal with it is by feeding it into milk or into flesh, and you will have a very large and enormous quantity of manure

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manure produced by the cattle that you so feed on the spot.

4868. In addition to the sewage?—Yes; consequently you will have the means of returning an immense quantity of manure to the land there. I would prefer a larger area, but no doubt that area would take the sewage of London.

4869. Could you state the area that you would think preferable to that?—50,000 or 60,000 acres I should prefer to 30,000 acres; that is a mere speculative opinion.

4870. Do you think 50,000 or 60,000 acres could be economically used for such a purpose?—Yes. Perhaps half of the grass food would have to be consumed on the spot; you might send a quantity of it to London for feeding horses, but that system is on the decrease; all the crops are being cut and eaten on the spot.

4871. Are you cognizant of the experiments which have been made at Rugby during three years by Mr. Lawes?—I have not interfered with them, because Mr. Lawes had the responsibility of them, and, in fact, I did not wish to have the responsibility.

4872. Therefore you practically cannot tell us anything about them?—I have made all the analyses.

4873. You made the original analyses of the sewer water; and what other analyses have you made?—I have analysed the grasses produced, and the drainage water afterwards.

4874. What is the result as to the drainage water; how much of the ammonia, and so on, was absorbed by the land?—A very large quantity of ammonia is absorbed; the drainage waters are comparatively low; I think that about three-fourths of the ammonia is removed at Rugby.

4875. You have stated that all the experiments for deodorization, whether with lime or with anything else, are to a certain degree failures, that is to say, they do not effectually perform that which apparently is asked of them; but is that the result of an experiment in your laboratory, or is it a practical result? Sewage deodorized by lime, you say, if kept, will stink; if you pour it into an ordinary stream with an ordinary flow, is it not, so far as it goes the better for the operation, and is not the water the better?—Yes.

4876. Therefore, practically, it may be that those experiments of deodorization or deposition may be, chemically, facts, though they do not succeed; but, so far as they go, they are a great improvement upon the present system, which is to pour the whole of the excreta without any such operation into the streams?—That is clearly so. Any doubt that may be entertained on that subject is due to the point of view from which a person wishing for information looks at the question. If you ask whether those experiments have been failures, as means of making manure economically, I say they have been failures; but I say that they have been to a great extent successes in purifying the water; and we most distinctly state, taking our report, that, so far as purifying the water and improving the streams are concerned, the precipitation by lime does affect a great amount of good.

4877. *Chairman.*] It does not remove the evil entirely, does it?—Not entirely, but very largely.

4878. Sir *Joseph Paxton.*] Does it not kill the fish?—If there were an excess of iron it would; but it is not very easy to see how you could put an excess of iron in.

4879. Mr. *Tite.*] Would the lime kill the fish, or would not that be a question of dilution like everything else?—Quite so; I think it has not killed them at Leicester.

4880. That is a small stream, is it not?—Yes.

4881. Is it wholly a question of dilution; if the ingredients of lime or iron that are used for the purifying of water are in excess, and drain into a small stream, they will kill the fish, will they not?—Yes.

4882. But if the dilution is considerable, and the stream is a tolerably large one, will they kill the fish in that case?—No; and more than that, with any common management, it is impossible to put an excess of lime, that is to say, the sewage contains so large a quantity of carbonic acid, that when you put lime in it carbonate of lime is formed. The object is to produce a precipitate, which in going down shall take those floculent matters.

4883. Supposing that at Oxford, or at Reading, or anywhere else, there may be such mechanical difficulties as to prevent the application of sewage-water to the land, would not the compulsory dealing with the water by chemical agents reduce the evil so as to render it practically of no importance?—It would very largely diminish the evil.

4884. Mr. *Hibbert.*] Do you know what is the mode in which the sewage is applied at Milan?—It is really not sewage there. There are certain streams, one of which is Vettabbia, which runs through Milan; it gets a variety of overflows into it, and the whole stream is used some miles down.

4885. That is merely irrigation from the stream, is it not?—That is all; and in comparison with that you have other streams which have not passed a large city like Milan, and we ground our belief that the sewage has had a fertilising effect, upon the fact that the water of Vettabbia which runs through Milan, produces much better meadows than the other streams.

4886. Sir *Joseph Paxton.*] Are those other meadows in the neighbourhood of Milan?—Yes.

4887. And there is a difference of value of some 4 *l.* or 5 *l.* an acre, is there not?—Yes, one point is this: we found that the temperature of the water of the Vettabbia was very considerably higher than that of the other streams in the neighbourhood.

4888. Mr. *Hibbert.*] You stated that the sewage could not be taken very profitably beyond 20 miles from any town; do you mean that it would not pay to convey it so far, or is there any other objection?—No, there is no objection; except that of expense; but I take it that there would be a limit to the distance for which pipes could be laid for the application of sewage; and the probability is that the sewage would be applied within from 20 to 30 miles of London.

4889. If sewage were conveyed 40 miles, would it suffer materially in any way?—Not at all.

4890. You say that the power of the earth to extract manurial matter from the sewage is limited; the limit of that depends upon the kind of soil, does it not?—Yes; soils differ very much in their capacity for remaining manurial matters from the sewage.

4891. Can you state what would be that limit in any particular class of soil?—I am afraid that I could hardly state that, because all soils differ; I have examined a good may soils in relation to known substances like ammonia, and so on; and I find that if plants are growing at the same time, on the soil, the power is renewed; the materials are taken out, and it makes a great difference.

4892. Do you know what would be the value of the Rugby sewage per ton?—Judging from the analysis, I should think that its value from the ingredients; (that is to say, apart from the question whether its ingredients are of the same value in sewage, which I dispute altogether), would be about, I think, 1 *d.*, or a 1¼ *d.*, or a 1½ *d.* per ton.

4893. Is the Rugby sewage richer than the London sewage?—Yes; I think it is richer in having a less proportion of water, that is to say, the water in the London sewage bears to the water of the Rugby sewage, the proportion of 100 to 60.

4894. In your opinion you do not suppose the London sewage to be worth in ingredients, 1½ *d.* a ton?—No; I do not think that it would be.

4895. You stated that you thought that 50,000 or 60,000 acres would be preferable to 30,000 acres for the application of the London sewage; do you mean that the Company undertaking to distribute the sewage should leave that quantity of land in their own hands, or that they should distribute it to farmers over that area?—I stated that any land to which very large quantities of sewage were to be applied, must be specially laid out for that purpose, and that it must not be supposed to be interpolated with ordinary farming, otherwise it will have to be taken over a very large area, and destroy my view of the case altogether.

4896. Is it your opinion that the farms to which the sewage is to be applied must be in the hands of the Company who distribute the sewage so as to give them the power of getting rid of the quantity of sewage which they would have?—That is not positively so; but they must be sewage farms.

4897. Have you not stated that the farmers would not take the sewage at all seasons, and that therefore there must be some power of disposing it when they will not receive it?—Yes; but that is an ordinary farm land; that does not refer at all to land which is laid out specially for receiving the sewage. I hold that to get rid of a large bulk of sewage, you must have land laid out for the purpose; it matters not whether that land is in individual hands under proper arrangement, or whether it is in the hands of a large company; I do not go into that question at all, but I say that it must not come into the system of general farming, or else you cannot get rid of it, and never will get rid of it. That is to say, if you were to lay down pipes over my farm, where I was farming in the ordinary way with a shift, and the ordinary courses of rotation, there are times when I should decline altogether to receive the sewage, and you would not be able to get rid of it, because all the farmers in the same district would decline to receive the sewage at the same moment.

4898. On those grounds, do you think that it would be desirable to distribute the sewage over farms which are specially prepared for the purpose?—Yes.

4899. And that those farms would have to be owned by the Company?—That last part of the question I have nothing to do with, but the land undoubtedly must be laid out specially for the reception of sewage.

4900. Do you suppose that farmers would have any objection to take the sewage for other crops besides the green crops?—It is very possible that they might take it when it suited them, but they will not take it so as to relieve you from it. There are two sets of people to this question; the people who want to get rid of the sewage, and the people who may not be prepared to take it at the time that you want to get rid of it.

4901. Do you know what the plan which is pursued at Leicester is?—Yes, I have seen it.

4902. Is that a successful experiment?—It has been a tremendous failure, as a money speculation.

4903. Is that undertaken by the town?—No, it was undertaken by a company, at a cost, I think, of something like 60,000 *l.* They made very large quantities of solid manure, by precipitation by lime, and they succeeded in selling some of it at first, but, generally speaking, they sold it to fresh customers every time; that is to say, a man used it, and then would not buy any more; and now they can only sell it at 2 *s.* a ton.

4904. Do you see any difficulty on account of the levels, in applying the sewage in the course of the Thames?—That is an engineering question, on which I would rather not give an opinion.

4905. Mr. *Ferrand.*] Do you believe that the whole of the sewage of London can be got rid of by applying it to the land?—Yes, I think it could, over a suitable area.

4906. Sir *Joseph Paxton.*] You stated, did you not, in your last answer about Milan, that the water of the Vettabbia, which flows through Milan, is of a higher temperature than the water of the other streams?—Yes; my impression is that we found that to be so, and I believe it is the case.

4907. Might not that, to a very considerable extent, account for the increased value of the land?—No doubt it would, to some extent.

4908. Would it not account for it to a considerable extent?—Yes; but as a chemist I cannot disregard the effect of matters which we know are manures.

4909. But are you not aware that applying warm water to land acts as a stimulant to the land?—Quite so; it alters the climate, in fact.

4910. Have you ever seen the irrigation which is carried out at Valentia in Spain?—No.

4911. You are aware, perhaps, that that system of irrigation is the largest in the world, being about 50 miles long?—That is the case, I believe.

4912. Are you aware that it is 10 miles broad in some places, and three or four miles broad in others; that the irrigation is carried on over every species of ground, the ground not being all in valley; that the irrigation has been carried on there since the days of the Moors, and that it is the richest valley in Europe?—Yes, I have heard that, but I am not conversant with it.

4913. Are you aware that that land grows every species of crop, even down to the sugar cane, and that it is only irrigated with pure water, and that that is a most successful system of irrigation?—I have heard that it is so, and I have no doubt that it is so, but it is not within my knowledge.

4914. You state that clay is the best deodorizer; have you ever turned your attention, or do you know much of Bagshot Heath and Woking, and those districts?—I know that district very well.

4915. You know that there are large tracts of sandy

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sandy land, which are not altogether sand, but partially sand?—Yes.

4916. Supposing that the sewage of London was applied there, what would be the result?—If it was applied liberally there it would grow crops, no doubt, precisely as it does at Edinburgh.

4917. The distance from the Thames is so considerable that it would have to percolate through the sand, which, to a certain extent, is of an iron character; what would be the nature of the water when it went back to the Thames?—It would be very much purified, no doubt.

4918. Do you think that it would be as much purified as the water which is at present supplied to London from above Teddington Lock?—That I can hardly say. As I have stated already, independently of the fact, that sand would remove all the solid suspended matter from the sewage; sand does purify, to a great extent, the dissolved matters. Dr. Angus Smith made some experiments some years ago, in which he took solutions of animal matter, such as beef-tea, and things of that kind, and filtered them through sand, and actually got rid of the whole of the organic matters by the filtration, although it was dissolved matter; he accounted for that (and other scientific men agree with him) by the fact that it was the oxidation of this matter due to the passage of the air round about each grain of sand. In the filters of the water companies you get rid, after filtration, of a good deal of the soluble organic matter of the water and the impurity; you get, not only the suspended matter, but that which is actually dissolved, removed by filtration and oxidation.

4919. If this sewage could be applied to sand some 50 or 60 feet deep, and were then to drain itself into the Thames, through a distance, perhaps, of four or five miles of sand, that would very much increase its purity, would it not?—Yes, that would be so.

4920. Would it not be possible to put in the reservoir a moderate amount of clay, which would in itself immediately assist the deodorization, and which would also cover and fertilise those barren sands?—I proposed that plan some years ago myself. First of all, I should say that sewage itself contains a very large quantity of *quasi* clay; it is much the same thing as clay, being the disintegrated granite of the streets, which is in point of fact, the origin of clay; a great deal of that which is very heavy, finds its way into the sewers; but there are some lighter portions, because in all our analyses of the sewage water, we have found a quantity of insoluble matter of the nature of clay amongst the other insoluble matters, and I believe that at Edinburgh, now the soil to a great extent has become a different soil from what it originally was by that means. It would be perfectly practicable to pump a little suspended clay on with every gallon of water, if you were doing it on a large scale, and it would be only a trifling increase of expense, because clay, when once suspended in water, subsides with great difficulty.

4921. In the course of a few years, supposing the water with clay suspended in it in the manner you describe to be carried on to Bagshot Heath and all that district, where you could find any amount of land suitable for the purpose, would not that form a valuable surface land as any perhaps in the country?—Yes.

4922. As the sewage progressed, it would require clay for the purpose of deodorization?—Yes.

4923. Do you think that that would be a good application of the London sewage?—I can hardly give an opinion about any particular place, and I should hardly wish to do so; but certainly there is no reason why you should not take a sand for the purpose, wherever it might be, if the engineering circumstances allow of it, and convert it into a proper soil to receive the sewage of London.

4924. But if the water could be pumped up to Bagshot Heath, and find its way pure again into the valley of the Thames, so as to pass through London, would not that be of great importance to London, as helping to fill the River Thames?—I understood the Honourable Member's question in the first instance to be, whether the water might come into the river so as to be notable. I think that to a great extent, it would be purified, no doubt, but the filling of the River Thames might be accomplished without that, probably, because you might introduce it where the water is not used for drinking purposes, that is to say, below Teddington Lock.

4925. But supposing that it were thoroughly filtered, it would still answer the purpose of being pumped again, would it not?—I should say that it would become very nearly pure. I know that water running off from cultivated arable fields, on which there has been a large quantity of manure applied, is used in many cases for drinking purposes, and it is very beautiful water too.

4926. Supposing that the district were laid out in the manner that you describe, you would carry out your notion of taking every portion of the value from the water?—No, I am not quite so sure of that. When I spoke of taking all the value from the water, it was under circumstances where nothing ran away; that would be the extreme value of a liquid manure; but if you put it on a limited area, such as 30,000 or even 50,000 acres would be, you must expect to lose some part of the value; whether it is offensive, is another question.

4927. But do you not think it very likely, that in passing over so great a distance, and flowing into the Thames again, it would come out comparatively pure?—It would come out comparatively poor, but still not free from materials which might have been used in agriculture.

4928. Have you ever analysed the water above Teddington Lock?—It is very possible that I have, but I do not recollect at this moment.

4929. Mr. *Caird.*] Following up the questions of the Honourable Member for Coventry upon the point as to the loss which the sewage would sustain by passing through the sands of Bagshot Heath, you have stated, have you not, that sands possess a peculiar property of separating the salts from the sewage, and that they also possess the property of retaining in their pores, by the process of filtration, a large portion of the solid matter of the sewage?—Yes.

4930. Would not such sands also be covered with a very rich vegetation thereby, and through that vegetation would they not retain a very large portion of the valuable qualities of the sewage which cannot be separated by filtration?—Yes; the existence of vegetation, as a matter of course, produces a great increase of the power of the earth, to remove matters from the sewage.

4931. Then if these sands to which the Honourable

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able Member has referred, were covered with a very luxuriant vegetation, through those three processes, namely, the power of separation which the sand possesses, the filtrating power, and the vegetating power, would not the sewage be to a very great extent deprived of all the qualities which are useful for vegetation, and which are injurious to the water for potable purposes?—Yes, very largely so.

4932. Would you not, therefore, conclude that such a soil would be admirably adapted for the purposes of the application of London sewage?—I think that such a soil is the soil that ought to be sought, without wishing to make any reference to Bagshot.

4933. You are speaking rather of the particular kind of soil upon which the sewage of London might be most profitably and most advantageously employed?—Yes; with my present knowledge of the subject, if I were a capitalist, and had to deal with a quantity of sewage, so as to use it to the best advantage, I should select a pure sandy soil in preference to anything approaching to a clay, because I can and should make a sand, by the application of sewage, richer in clay every year that I applied sewage to it, apart from the fact that I could add the clay purposely if I wished it; but I could never get a clay soil open enough to receive sewage.

4934. Would not the gradual deposit of the sewage on the land very soon correct the light quality of the sand to a great extent, and convert it into a useful soil?—To a certain extent, it would; but that would not be the case so much where sewage is pumped from a long distance, because the solid matters in the sewage would subside in the act of pumping; it is so in the case of Edinburgh, but there the sewage runs by gravitation, and in time of storms the sewage carries away with it the lighter articles of deposit.

4935. Looking to an application of sewage over a certain extent of soil, would you not consider that a friable soil, such as that with a sand so treated would present, would be more profitable than a stiff, strong clay?—Certainly it would; for the liberal application of sewage.

4936. The natural advantage which, chemically, a clayed soil possesses, of taking from the sewage and absorbing a certain quantity of the fertilizing matters, and which the sand does not possess, would be thereby done away with; in fact, the sandy soil, from its other economical properties, would be more advantageous?—Yes; but I believe that the sandy soil would become a light friable loam by the deposit of the suspended matters in the sewage. Among the organic matter of the sewage you find a quantity of insoluble mineral matter, which is nothing in the world but finely divided granite.

4937. So that the sewage of a great town like London must be taken every day in the year, as it comes from London; would not the very fact that it must be taken, perhaps, at times which would be very inconvenient to a farmer, lessen its value per ton, when it was looked at in a commercial light, as compared with its theoretical or chemical value?—Clearly so; if you could bind a farmer to take it at all times, he would not be so bound for many years; and, as soon as he found it very objectionable to take it in times of wet, as it would be, he would throw up the contract at the end of his time; indeed, he could not take it at all times.

4938. Suppose that a great Company were established to utilise the sewage of London, might it not be found by that Company to be a very profitable mode of dealing with the sewage to sell it to the farmers along the line of their culvert, at times when the farmers were anxious to get it, and would offer a large price for it; and at other times to use it upon other lands of their own, which they had laid out for the purpose?—Yes; it would be a great boon to the farmer when he wanted it.

4939. At certain seasons, for instance in the month of May, when the whole chance of a hay crop might depend upon a fall of rain along such a line of country, might it not be a great advantage to a farmer to have the power of taking the sewage in that way?—Yes, quite so.

4940. And could not the farmers for such an advantage afford to pay a large price?—They would undoubtedly, that is with the optional power of taking it and leaving it when they liked.

4941. And the Company that could give that optional power, and could apply the sewage usefully on land specially prepared for it, would be in a position to derive the largest amount of profit from the use of the sewage, would it not?—I should think so.

4942. You stated, as I understood, that no deodorising would be necessary; do you mean that no smell attends the application of sewage such as that of London in large quantities upon the surface of the ground?—I did not exactly mean that; but I mean that if it is put in small quantities no smell would attend it; that is to say, if it is put on by hose and jet as it has been done in several places; if it is put on in very large quantities, my own conviction is that it would be put on farms which had been regularly laid out for the purpose, and these farms would be sure to be away from the centres of population where it was likely to be injurious.

4943. By the hose and jet you would throw it up in showers in the air, would you not?—Yes.

4944. In that form would it not be more likely to give an offensive smell than if it passed off on the surface of the ground?—Yes, but it does not smell so badly as liquid farm-yard manure. Mr. Mechi's farm has been constantly quoted as an instance of irrigation by sewage, but it is not sewage at all, and it has no assimilation to sewage; it is a solution of all the dead animals that he can get, and everything that is nasty.

4945. It is not in the slightest degree the same thing as London sewage or town sewage of any kind?—It is perfectly ridiculous to call it sewage; you might compare superphosphate and guano as manure for corn just as well; compare Mr. Mechi's liquid manure with town sewage, it is not the same thing at all.

4946. You stated, as I understood, that if you desired to obtain the greatest absorption by the soil of the intrinsic qualities of the sewage, you would choose to apply it upon a large area?—Theoretically, in the abstract, I should.

4947. Had your answer reference to this, that by having a large area, not a particle of the fertilising matters should be lost without any regard either to the cost of applying it, or to the profit that would attend its application?—Quite so; I say that it is not profitable to apply it on a large area.

4948. You would not, as a matter of profit, choose so to apply it?—Certainly not.

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4949. Have you formed any idea of the limit per acre to which, in a profitable point of view, you consider that sewage ought to be applied?—I do not think that that is a matter falling within my particular experience, but I myself should like to employ the sewage of from 50 to 100 people per acre.

4950. What number of gallons or tons of sewage would that be?—In London, with the population that we have, it would be about 60 tons per head per annum, that would be 3,000 tons from 50 people, or 6,000 tons from 100 people.

4951. To what crops, in your opinion, could sewage be applied with the most advantage, economically?—To grass, either natural or artificial.

4952. Have you considered at all whether it might not be profitably applied to vegetables of all kinds which grow at a low temperature?—I do not think so. Vegetables, we will take cabbages for instance, do not bind the ground, and if you were to irrigate with sewage over land which is not tied with the roots of plants, you would wash it about and destroy it, and you would sodden it; for vegetables, you must come back to the hose and jet system.

4953. It is upon your recent analysis of the London sewage, as well as of the Rugby sewage, that you rely, as we are to understand, for your present belief in its value?—Yes, I think that those three analyses of the sewage from the Northumberland sewage for instance, are much more correct although they are considerably above the average of the London sewage. I always hold with reference to sewage, that if you take a population of the same ages, say 100,000 people, which would probably be a fair average, whether in one place or another, males and females, children at a given age and adults. My conviction is that you get a better idea of the sewage of a town by taking the number of the population that contribute to that sewage, and the quantity of rainfall and water supply, once having fixed those data, than you do by any analysis in the world. I take it that although 93 analyses have been made at various times during the last three years of the Rugby sewage, yet if we had the data as to the quantity of water which accompanies that sewage, and the population which supplies it, we should get a better means of calculating it than by any isolated analysis of the sewage.

4954. You think that by having the number of the population and the water supply, you could arrive at a very definite idea of the value of the London sewage, with the analyses which you have already in your possession?—Yes, I think so.

4955. Can you give us any idea of the chemical value of the London sewage?—If I judge by the Rugby sewage, which is the best way of judging at this moment, and compare the quantity of water running into the drains in Rugby and in London, which I take to be as 60 to 100, I consider that the average of the sewage of London would contain between four and five grains of ammonia in the gallon, but not more than that. Eight pence you may take as the value of the ammonia, accompanied as it is with phosphoric acid and potash; it is always in the same relation, and instead of putting down the value of those separate ingredients, you may increase the value of the ammonia to meet that value. I think that 8 *d.* a pound is about the value of the ammonia.

4956. What would that be in a ton of sewage?—Supposing there were four grains in a gallon, that would be, I should say, about ½ *d.* or ¾ *d.*

4957. But what would be the commercial value; do you make a difference between the chemical and the commercial value?—I make a very great difference.

4958. Can you state what you consider to be the commercial value of the sewage?—That can only be arrived at by the experiments which are being made at Rugby, and the quantity of grass that you can grow.

4959. And the distance to which you have to take the sewage?—Yes.

4960. It involves all those considerations, does it not?—Yes.

4961. Is the value which you have just given the chemical value of the constituents at the sewer's mouth?—Quite so.

4962. And all other expenses have to be deducted from that chemical value, have they not, before you arrive at its commercial value?—Yes; and more than that, I say, that the commercial value is not the value of the ingredients, minus the expenses, because there are times when, of course, the water of the sewage would be valuable, and increases that value; but there are a great many other times when the water would be a great annoyance, and a great interference with the farmer's business, and he could not use it. It is a tremendous drawback to the value of the sewage, that it has all that water with it. In all those analyses, in computing the value, we compute the actual constituents as if they were solid. I gave, on my first examination, and I may, perhaps, be allowed to repeat it, an illustration in the shape of gold quartz and gold. I say, that if a man owes me the value of an ounce of gold, 4 *l.* 15 *s.*, and if he comes and gives me a ton of quartz, and says, "There is an ounce of gold in this ton of quartz," it is not paying me. That is precisely the condition of the sewage; you have the water, and you must have it at all times, even when you do not want it; there are months and months when we do not want water in this country, except for grass.

4963. You have stated, in answer to a question put by the noble Chairman, that if there were no new discoveries of guano, or other natural manures of that description, the value of artificial manures must rise very greatly; is that your decided opinion?—I think so, as the information which shows the expediency of making them increases.

4964. Would it not also follow, naturally, that if there were no such discoveries made, the value of sewage must rise considerably?—It would keep pace with the value of the others.

4965. By guano and those other things being supplied in a limited quantity, naturally sewage must rise in value as years flow on, must it not?—If the sewage were to do all that its greatest advocates wish for, it would increase the supply and the demand which would certainly arise for manure in this country.

4966. With regard to the injury which might be done to manure makers by the use of sewage, is it not possible that with a very high system of farming, a farmer might find it greatly to his advantage to dissolve guano, and other artificial manures, in the sewage, which he is able to lay upon his land?—Yes.

4967. Might

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4967. Might not there be created a new demand for such artificial manures, through the instrumentality of sewage as a carrier upon the ground?—Yes; that has been stated by Baron Liebeg.

4968. In that way do you not think that the interests of the manure makers and the great towns, are not in any way incompatible with each other?—Yes, Baron Liebeg has said, that the manure makers are opposed to the use of sewage, because it would interfere, as they think, with their business. But he says at the same time, that they are very blind to their own interests; that they should in fact encourage the use of sewage, because it would become necessary to add their manures to the sewage, so that he accuses them on the one hand of an interested motive, and on the other hand of being so blind as not to see where their real interest lies.

4969. *Chairman.*] I think you stated that to apply all the sewage of London, would require an area of 60,000 acres?—I stated that I should prefer 60,000 acres to 30,000 acres; but that I thought that 30,000 acres would take it all.

4970. Sixty thousand acres is 93 square miles, is it not?—Yes.

4971. You are aware that Messrs. Hoffman and Witt, at page 25 in the Report of the Metropolitan Drainage, state that if you are to apply the sewage of London as thickly on to the land as it is applied at Craigentinney, near Edinburgh, it would require 90 square miles for the application of that sewage?—That is so.

4972. But they also state that such a quantity of sewage would stink and affect the purity of the atmosphere during certain times of the year; and that it would eventually pollute the springs and streams?—Yes.

4973. Now, if you look at the Report of the Board of Health, they state (and it seems to agree with your evidence) that the quantity of fluid applied at Craigentinney is so enormous that a very large proportion of it escapes into the sea without being productive of any good; you stated that that was the case, did you not?—Yes.

4974. There the application is 18,000 tons per Scotch acre, which would be equal to about 6,400 tons per English acre?—I fancy it is very much larger than that. The sewage of 300,000 people is applied over 260 acres, I think. I should never advocate the use of sewage in the way in which it is used at Craigentinney.

4975. That is too large a quantity, you think?—The object is merely to get rid of it. Nobody would set to work to deal with the London as the Edinburgh sewage is dealt with; we use it as an illustration, but we do not propose it as a thing to be adopted.

4976. If you wanted to utilize the sewage, with the object of making a profit, you would use it in far less quantities, would you not?—Yes.

4977. And if a certain portion of land, say 60,000 acres, were sufficient to receive the sewage if it were to be taken at all times, would you not require a much larger area if it were to be taken and utilized only when convenient and beneficial to the land?—Yes, an immensely larger area.

4978. Have you not stated that you could not apply the sewage to all crops, because it would wash about the ground so?—I said that you could not by irrigation apply it to all lands. That was in answer to a question from the Honourable Member for Stirling, who asked me whether it would not be useful to vegetables; but I took it for granted from his questions, that we had already got to this point, that it was to be used only in irrigation.

4979. If you could apply it by hose and jet, do you think that it would be beneficial?—I wish it clearly to be understood that I do not say that small dressings are not beneficial, on the contrary, I think they are beneficial.

4980. Then it would be beneficial if applied to corn?—Yes, a small quantity; it could not be applied in very large quantities.

4981. Did you not state that a great drawback to the value of the sewage was its having all the water in it?—Yes.

4982. Then, is this Report of the Board of Health, 1852, incorrect, when it states: that not only is the produce improved, but that offensive emanations are prevented by greater dilution with water; and again, that the most beneficial results are obtained when the sewage water is considerably diluted; do you not agree with that?—Yes, but those are cases where it is used over grass, I expect, and by hose and jet, where the quantity put on under any circumstances cannot be very large.

4983. You stated that the amount of the London sewage was 60 tons per person; do you take Mr. Bazalgette's estimate of five cubic feet per person per diem?—I take the quantity of water supplied in London at about 35 or 36 gallons per head per day; that is mentioned by Messrs. Hofmann and Witt, as they have received it from Mr. Galton.

4984. Then do you think that the amount per person in the year would be about 50 or 60 tons?—Yes.

4985. You stated that during the next 20 years there would be a great dearth of artificial manures, did you not?—Yes; I meant to say that as information on the great advantage of using artificial manure, spreads through the country (because at this moment I do not suppose that one-tenth part of the whole of the land which should be manured with artificial manures, and which could be profitably manured with artificial manure, is so manured), and as farmers come to use more super-phosphate and all those things, there would be necessarily a want of supply of the raw material unless more was found.

4986. But I believe that long before that, there will be no guano; that supply will very soon be exhausted, will it not?—I think there is a supply for 20 years.

4987. Are there materials to make all the other artificial manures in sufficient quantities?—I believe that next to guano, the great artificial manure is super-phosphate of lime, which is made from phosphates of any kind, like coprolites or burnt bone, bone ashes, or animal charcoal, which is carbonised bones; and it is also made from the mineral phosphates which are now obtained in considerable quantities from mineral veins in the ground.

4988. Is not the supply of those also likely to run short?—I do not think it will; at the present moment there is hardly enough supply to meet the wants, but a large new deposit has been opened up in Estremadura, in Spain, which is called phosphurite. Some City merchants have taken the estate upon which this mineral exists. They have made a railway, or are making a railway of about 30 miles, to join on with the main line, and they intend to bring it in large quantities into

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into this country. What is known of that deposit is that it is very enormous; it runs for several miles in one track, and how deep it goes they do not know. I do not see why it should exist there, and should not exist also in other parts of the world. In fact, it is known to exist in Canada.

4989. But if the supply of artificial manures is now short, and you expect that the use of them will be very much more extended than it has formerly been, of course the price must rise, must it not?—Yes; but the very fact of its being short, and there being a great demand for this phosphate of lime, is leading to the opening up of new supplies. I am not so much afraid of a deficiency in the supply of phosphate of lime, which is really a turnip manure, as of the deficiency of supply of ammonia and guano. When those run short we do not know at this moment of any means of supplying them. There is no natural source of ammonia except guano.

4990. Mr. *Tite.*] When you speak of ammonia, and the analysis giving seven grains in a ton of sewage, in what form do you get it in your laboratory?—It is partly as ammoniacal salts, dissolved in the liquid. When you first take a sample of sewage some of the urine ingredients, the animal matters of the urine, have not passed into the state of the ammoniacal salts; but after keeping a few days they do so pass, and you then got the ammonia in the shape of ammoniacal salts. You get not ammonia but nitrogen, which is equal to ammonia in the solid or organic matters which is floating about the sewage.

4991. When you speak of ammonia being worth 8 *d.* a pound, in what form is it, commercially speaking?—It does not matter very much how we get it; we put the same value upon it if it is not ammonia, but if it will only form ammonia in the soil; for instance, cuttings of leather or woollen rags do not contain any ammonia, but they contain nitrogen, which will produce ammonia by decomposition.

4992. After that, you have all the cost of working into the land?—Yes.

4993. You have been asked by an Honourable Member whether, if you could supply the farmers along the line of your great sewers with sewage-water exactly at the time they wanted it, they would eagerly purchase it at certain seasons, it being, of course, quite obvious that it would be their interest to refuse it at those seasons when they would not desire to use it at all?—Quite so.

4994. How do you imagine that, mechanically, that would be done with our sewers; are we to tap them, like a barrel?—You could not do that with your sewers. I understood the Honourable Member for Stirling to ask me whether, if a company were formed for taking the sewage out some distance from London, they could make arrangements for distributing it to the farmers along the line of their pipes.

4995. You do not apprehend, of course, that we could do anything with it for utilising the sewage; that must be some great company, with some great system, and if they could add to the ordinary system that of taking the sewage-waters, and then of distributing it, do you think that that would be a great convenience to the farmers, and that they would be more likely to take it in that case?—Yes; it would be the duty of such a company to make arrangements for taking the whole of the sewage, whether their *clientelle* on the way took it or not.

4996. Mr. *Ferrand.*] Do you believe that sewage can be applied in open drains to land without any offensive smell arising from it?—No; open drains are a great objection; they are the chief objection at Edinburgh.

4997. That is very powerful sewage, is it not?—Yes, and the nasty stuff hangs about the edges of the drains, and putrifies; it washes round the corners, for instance, and it hangs in the grasses that dip into those little streams. It is those things that are so foul and offensive, and not the land itself.

4998. Do you think that the sewage from a village of 3,000 inhabitants could be applied in open drains to land in the neighbourhood of a highroad, without an offensive smell arising from it?—I think that if you took the sewage down in pipes to the land, and if the main feeders of the land were pipes also, and if the open conduits were only necessary for irrigation, there would be no offensive smell.

4999. Have you seen sewage applied in that way?—I have.

5000. Did you perceive any offensive smell from it?—I cannot say; it depends so very much on the quantity and nature of the sewage.

5001. Mr. *Hibbert.*] Do you know whether anything offensive has arisen at Rugby from the application of sewage?—I have not heard of it.

5002. You have stated that probably in a few years there will be a scarcity of guano, and a great increase in the cost of artificial manures; would not that make it likely that the sewage would be more looked after by the farmers, and more acceptable to them than it is at present?—If you can get over the difficulties, that would be so.

5003. Presuming that they are in a position to apply it to their lands?—Yes; the sewage would go up *pari passu* with any other manures, as a matter of course; the only question is, what its value is at the starting point. Now, I have never underrated the value of sewage; I only look at the great difficulties; and I believe that the difficulties of applying it in small quantities over a large area are almost insuperable.

5004. Sir *Joseph Paxton.*] Did you ever see it tried for osier beds?—No.

5005. Would it assist in deodorising the sewage, supposing that it passed through osier beds as the last place?—I do not know, but osier beds are generally swamps themselves.

5006. You can make them so or not, of course?—Yes.

Mr. Samuel Bury Congreve, called in; and Examined.

Mr. *S. B. Congreve.*

5007. *Chairman.*] You have a farm near Rugby at present, have you not?—Yes.

5008. Are you a tenant farmer?—Yes.

5009. How long have you had that farm?—Thirteen or fourteen years.

5010. Had you the farm before they began to apply the sewage?—Yes.

5011. At first, was not the sewage applied by Mr. Walker?—Yes.

5012. And then after that Mr. Lawes made his experiments,

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experiments, did he not?—Yes, two or three years afterwards.

5013. Mr. Walker applied the sewage before Mr. Lawes did?—Yes.

5014. Can you give any opinion of Mr. Lawes' application of the sewage, as to its value?—It was perfectly worthless.

5015. Do you mean to say that greater crops are not procured by means of the application of sewage?—Greater crops are procured, but they are of a much worse quality; the land grows a greater quantity of grass, but that grass is not of the same value as the grass that grew there before.

5016. Have you seen the report which Mr. Lawes has given of his experiments?—Not the last report.

5017. He states that he has got upwards of 32 tons an acre, and that the amount of milk he procures from feeding on this grass is very great indeed?—Mr. Campbell does not say so, I think. He has carried out Mr. Lawes' experiments. He had all the grass, and consumed it all.

5018. Does he do so now?—He does so now.

5019. Do you think that his opinion on the subject would be conclusive?—Mr. Campbell would give you very good evidence upon the subject, no doubt.

5020. Mr. Campbell published a pamphlet in the year 1862, a copy of which he has sent to me, in which he states that he "knows where sewage is skilfully applied, and has been so for many years, that they have obtained as much as 40, 50, 60, 70, and 80 tons, per Scotch acre of grass in one season by an application of probably not more than 3,000 tons of sewage." Do you believe that?—No, I think that he is mistaken.

5021. He has also stated in another pamphlet which was published in the year 1861, that he can "imagine no better way to dispose of the sewage of our towns under the existing system of water-closets, than by irrigating the land, and that under proper management it may be made to pay good interest, at least upon the proposed outlay, if not, indeed, to pay off the whole in time." Do you not agree with him in that?—Decidedly not.

5022. Are you speaking from what you have seen of the practical application of sewage?—From what I have seen of the application of sewage and from my own experience of it.

5023. Before Mr. Lawes began his experiments, was the land deteriorated by the use of sewage?—Decidedly it was, in value.

5024. And the larger crops, which were produced by the application of the sewage, were not of so great a value as the smaller crops had been before?—Not nearly so.

5025. What is your opinion with regard to the large quantities of sewage that Mr. Lawes has applied; has it made the land worse?—I believe it has.

5026. Since Mr. Lawes has applied sewage, the land is not nearly so good as when it was in Mr. Walker's hands?—Certainly.

5027. Do you mean to say, also, that it was in a worse condition when Mr. Walker gave it up to Mr. Lawes than when Mr. Walker received it?—No; because one piece had not been sewaged before Mr. Lawes took it in hand, and the result ought not to go forth as the result of the application of sewage; that land was thoroughly drained and manured before he began, and it would have produced much better crops before the sewage was applied to it. Therefore, Mr. Lawes' results are complicated results, and the results of good management previously.

5028. Was not the land sewaged before Mr. Lawes took it?—Not that one piece.

5029. One portion of the land received no sewage; do you consider that that land is superior to the other portions that received the sewage?—It is worth infinitely more money to rent, but it does not bear greater crops; only what it bears is of much better quality.

5030. Is the most sewaged piece the worst of the three?—I should say it is, decidedly.

5031. How is Rugby supplied with water; is it not supplied by means of a tower, which is called the Water Tower?—Yes, by drainage; it comes from the Water Tower.

5032. And that supply is, on the average, 97,000 gallons daily, is it not?—Yes.

5033. The maximum being 190,000 gallons, and the minimum being 35,000 gallons, so that the supply is very unequal?—Yes; and the supply is least in the most useful time, that is, the summer.

5034. Then the sewage flows through round pipes into a tank, where it arrives half an hour after it has been ejected from the houses?—Yes.

5035. Therefore, it arrives into the tank before it is decomposed?—Before it is thrown on the land.

5036. Then it is pumped up by a 12 horse-power engine, is it not?—Yes; from the tank through iron pipes.

5037. And then it is applied to 400 acres of land, is it not?—Yes.

5038. If the water supply of Rugby is so very unequal, some days you would have the sewage very strong indeed, and on other days rather weak, would you not?—Yes; it varies considerably.

5039. Some days, is it not so strong as that it would actually burn up the land?—No; it is never too strong.

5040. There are upwards of 8,000 people in Rugby, are there not?—Yes.

5041. And the sewage of those 8,000 people is diluted on some days with only 35,000 gallons of water; is not that so?—Yes; but it would be more diluted from pumps and other things, which are not taken into these data; that is the mere water that comes into the works.

5042. Would not that be very strong?—I never found it very strong; the great difficulty with it has been that it is too dilute, that it has too much water in it.

5043. From experiments with sewage of such variable character you could hardly come to any just conclusions as to the value of the sewage, could you?—I dare say that might be an element, but we have never had it too strong; it has always been too weak. The great difficulty has always been to get rid of the water in it, because it is much too dilute.

5044. Is the land well drained?—Yes, and it is very well suited for the sewage; it is a very good subsoil, and very porous.

5045. Are you of opinion that the application of sewage would be actually injurious instead of being beneficial to the land?—Some of the land at Rugby was good feeding land previously to the application of the sewage, and the sewage being applied to that land certainly deprived it of its feeding powers; feeding land is at present the most valuable land that we have.

5046. Do you think that to other land it might be

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be beneficial?—It would produce a great quantity of green food, which, if cut and carried away, would be useful.

5047. If applied to fallow land, would it not grow corn well?—No, you get no corn from it; you get a great quantity of straw and rough corn, but there is scarcely any ear from it.

5048. Then do you think that the farmers of England would not be very apt to take the sewage?—On poor grass lands, and at certain times it would be very beneficial no doubt.

5049. And at certain times would it not be beneficial upon all lands?—It would be very beneficial upon all grass lands, but I don't think it could be applied to ploughed land.

5050. Mr. *Tite.*] Is any of the land which Mr. Campbell holds close to yours, or is the soil of the same nature?—Mr. Campbell's land is inferior to the land which I held; I held the land on which this sewage is poured at that time and before.

5051. When did that pass out of your hands?—At the end of 1860.

5052. Then you are perfectly conversant with the nature of the experiments which were made by Mr. Lawes on the lands in question?—Yes, I have seen it the whole time from first to last.

5053. Do you consider that it is a failure?—I do not know at all, it is such a varied question. Mr. Lawes shows that sewage will produce a very great quantity of grass, but he does not say anything of the quality of the grass. I consider that he has deteriorated the quality of the grass.

5054. Could you pay your rent as well, the sewage being poured over your land as you could without it?—Decidedly not.

5055. Therefore, your rent would be less than if was before, would it not?—Decidedly.

5056. Does it destroy the finer grasses?—Yes, it destroys the finer grasses, and encourages the coarser ones. As an instance of that, I may say that the hay from a field which, before the sewage was applied, was one of the best fields in that neighbourhood a little while ago, was worthless.

5057. So far as you are concerned, am I right in the conclusion that if pipes were laid down to your farm (supposing you to have a farm in the neighbourhood of London), for the purpose of conveying the sewage on to your land, you would decline to be a customer for it?—If I were compelled to take it at all times I should.

5058. But supposing that you were at liberty to take it when it suited your purpose?—I should apply it to a very limited area, at a certain time of the year.

5059. Would that be under circumstances due to atmospheric causes as well?—Decidedly.

5060. And if the atmospheric circumstances were in your favour you would not take it at all?—Certainly not.

5061. You do not seem to think that the application of sewage to arable land is at all judicious?—Decidedly not, except on clover and on poor arable land when it is in grass; but you cannot apply it to cereals at all, and I do not think you can apply it with any good effect to roots.

5062. If the sewage were to be applied at all times of the year, it would be extremely difficult to deal with?—I would not have it at all under that condition.

5063. Mr. *Ferrand.*] Then it is your opinion that sewage applied to poor land will greatly increase the crops?—It will greatly increase the grass crops.

5064. And the arable crops also?—In the case of arable crops it will increase the quantity of straw, but not the quantity of corn.

5065. Will its effect be good upon turnips and green crops, such as mangold?—You cannot apply it to those kinds of things with any good effect, because it contains so much water, and is so very weak, that your land is almost in a state of sea if you get any quantity into it.

5066. But the strength of the sewage depends very much upon the quantity of water that is applied, does it not?—No; the sewage is very diluted, and there is very much water in it.

5067. You may give it too much water; for instance, if you put a glass of wine into a gallon of water, you would not taste much of the wine?—I should think that that is about the proportion which the sewage bears to the water.

5068. Do you consider the land at Rugby to be over-tilled by the sewage?—The finer grasses have been destroyed, and the coarser ones have been stimulated.

5069. The land was in a very high state of cultivation before, was it not?—Yes; it was very good land.

5070. Therefore, there was no occasion for the sewage to be applied to this land?—The sewage has done it harm, so far as feeding purposes go.

5071. Is it not your opinion that if you were to apply farmyard manure to a very great excess, you might destroy the finer grasses by that also?—Yes.

5072. Therefore, it is merely a question of quantity, is it not?—No, I do not think that; I do not think that a small quantity of farmyard manure would have the same effect as a small quantity of sewage.

5073. Did you not answer my question by saying that you might also destroy the finer grasses by an overdose of farmyard manure?—Yes; but it would be in a different way, because an overdose of farmyard manure would smother them. You would kill them by suffocation, as it were, by putting any weight upon them; but if you only put sufficient farmyard manure on the land to be washed into that land, and fertilize it properly, you would not destroy the finer grasses at all.

5074. Then, what is it that destroys the finer grasses when the liquid manure is applied?—It is the quantity of water that is always applied with the manure.

5075. Is it nothing but the water?—I believe so. You produce hassocks and all the coarse grasses, and destroy all the finer ones.

5076. Mr. *Sclater-Booth.*] Water meadow-grass is always coarser, is it not, than other grasses?—Always.

5077. Mr. *Ferrand.*] But if you were to apply liquid manure in small quantities to grazing land, is it your opinion that that would destroy the finer grasses?—Not if applied in very small quantities, but then you would produce scarcely any results; you would not see it.

5078. Then is it your opinion that if you were to apply, say, 1,000 tons of liquid manure to the acre on a grazing-field, that would destroy the finer grasses?—Decidedly.

5079. Have you seen it tried?—Yes.

5080. Was it very strong sewage?—No, very weak.

5081. Mr. *Sclater-Booth.*] Perhaps that was partly the reason?—That may have been the reason.

5082. Mr.

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5082. Mr. *Ferrand.*] How often was it applied in the year?—It was applied four or five times.

5083. Did it destroy the finer grasses?—Yes, decidedly.

5084. Was that at Rugby?—Yes.

5085. Was the land in a high state of cultivation before?—Yes; it was very good land before.

5086. And, therefore, it did not require the sewage?—It did not want it.

5087. Might it not be that, the land being in such a state of high cultivation before the application of the sewage, the finer grasses were killed by an overdose of manure?—No, I do not think so.

5088. Is it your opinion that it was nothing but the water?—The quantity of water.

5089. It had nothing to do with the strength of the sewage?—It had nothing to do with the strength of the sewage, decidedly.

5090. Sir *William Russell.*] On this land that you had were natural grasses growing?—The bulk of them were natural grasses, decidedly.

5091. And they were what you call feeding meadows?—Yes.

5092. Do you believe that it would have injured the ground if it had been broken up and grown with ryegrass and other artificial grasses?—It has done so; but when it has been applied by Mr. Campbell to ryegrass, it has not produced a great result, and has left the land in a wretched state after it.

5093. What is the nature of the soil?—Mr. Campbell's soil adjoins Mr. Walker's, and is not so good by a great deal; it is a sandy soil.

5094. Were you in the farm when the whole of the experiments were going on?—I was in the farm from its first commencement till 1860.

5095. And you gave up the farm yourself in consequence of these applications of the sewage injuring the soil?—Decidedly so.

5096. Might I ask what rental per acre the farm averaged when you had it?—I did not rent it before the sewage was put upon it. It never was let, I fancy; it belonged to Mr. Walker himself. I should certainly have liked to have given more rent for it before than I should now.

5097. What is the rental per acre?—About 3 *l.*

5098. *Chairman.*] What do you mean by saying that you did not rent it before Mr. Lawes came there?—Before Mr. Lawes came, not before the sewage was applied to it first, I managed it for Mr. Walker, and then I rented it from Mr. Walker.

5099. Then when Mr. Lawes came you lost the farm?—I gave up the farm.

5100. Had you the farm in your own possession after Mr. Lawes began his experiments?—I think I had, but I had never anything to do with Mr. Lawes; he sold his grasses to Mr. Campbell. The places are separate and distinct.

5101. Was it not a part of your land that Mr. Lawes had before?—A portion of it; in fact, I occupied both at one time.

5102. Was it with your consent that he applied those large quantities of sewage?—It was taken from me, at that time.

5103. Who took it from you?—Mr. Walker took it from me, at least I was willing to give it up; there was no compulsion.

5104. He took it from you, in fact, in order that the experiments might be tried; was that so?—Yes.

Lunæ, 27° *die Junii*, 1864.

MEMBERS PRESENT:

Dr. Brady.
Mr. Sclater-Booth.
Mr. Caird.
Mr. Ferrand.
Lord Robert Montagu.
Sir Frederic Smith.
Sir William Russell.
Mr. Tite.

LORD ROBERT MONTAGU, IN THE CHAIR.

JOSEPH WILLIAM BAZALGETTE, Esq., recalled; and further Examined.

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5105. *Chairman.*] WHEN was the general scheme of the Main Drainage approved of by the Metropolitan Board of Works?—Before I answer those questions, I have to state to the Committee that Mr. Thwaites is not present on account of his having left London before he received the order of the Committee to attend the meeting of to-day. I understand that I am here to give information with respect to the main drainage, on account of certain allegations having been made to the effect, that errors have been made as to that system. Up to this moment I am perfectly ignorant as to the nature of the allegations, or as to the person who has made those allegations. I need not tell this Committee that, since the main drainage works were first commenced, as the official of a Public Board, I have from time to time had to answer allegations of every description.

5106. Before you go on, let me ask you whether any allegations have been made?—A rumour has reached me that certain allegations have been made. I submit to your Lordship whether it would not be fair to me that I should know what the allegations are, and who has made the allegations. I have frequently from time to time had to any answer allegations against me; but up to the present time I have never had to answer anonymous assailants on vague information. I submit it to the Committee as an act of fairness, if they will allow me to suggest, that if there are such allegations, they should allow the person making those allegations to appear before them as a witness, and to prefer his charges, and I should be content to meet him and answer his allegations.

5107. From whom did you understand that you were to be examined concerning certain allegations against you?—I think I have heard from the Chairman of the Board of Works, Mr. Thwaites, and from Mr. Tite, that certain rumours were afloat to that effect.

5108. Then it was in consequence of what the Honourable Member for Bath said, that you imagine that you are going to be examined concerning certain allegations?—I have given you the names of two gentlemen, but I think I may say that I have heard it from other sources also.

5109. But from no other Member of this Committee?—No.

5110. When was the general scheme of the Main Drainage approved of by the Metropolitan Board of Works?—In 1858 it was finally approved.

5111. And when was it approved of by the Commissioners of Works?—The veto requiring the approval of the First Commissioner of Works was withdrawn by Parliament a short time previously.

5112. Was the Main Drainage Work carried on according to the plans contained in your report of May 1856?—No, it was not; the Main Drainage Works were, in fact, originally designed piecemeal, commencing with the late Commissioners of Sewers; they were commenced, I may say, by Mr. Frank Foster, with Mr. Haywood, and they were taken up by me in 1856; I was engaged upon it before the old Commission. It was taken up again by the Metropolitan Board of Works, immediately on their coming into office in 1856; the northern drainage was reported upon by me in that year, and the southern drainage in the same year. It was then submitted to the First Commissioner of Works for his approval, and his approval was withheld with respect to the point of discharge; it was then referred to a Royal Commission to report upon, and the report of that Royal Commission was afterwards referred to Messrs. Bidder, Hawksley and myself to report upon again; during the course of that period the plans were from time to time modified; and they were finally adopted in 1858, upon the basis of the joint report of Messrs. Bidder, Hawksley, and myself.

5113. Have you a plan with you of the works of 1858, as they are now being carried out?—Yes. I should state that that plan is the general design for the Main Drainage Works, and that detail drawings, such as are laid before the Committee in those books which are upon the table, were prepared for each contract.

5114. It was divided into a number of contracts, was it not?—It was divided into a number of contracts. The general scheme of 1858 having been approved of in its main features, it was then determined by the Metropolitan Board of Works to divide it into convenient sized contracts, to prepare working drawings and specifications for each contract, and to submit those to public tender, with an estimate accompanying each portion of the work.

5115. What was the original estimate for the

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works according to that plan?—I will give you the estimate of the whole, if you will allow me to do so, by reading extracts from a report made to the Board of Works in June 1863, by which means I think that the whole thing will be laid before the Committee, showing that there has been an increase in the cost of works since the estimate was made in 1858, and showing the reason of that increase. The report is one made by myself, dated the 3d of June 1863, to the Metropolitan Board of Works; it contains quotations from the reports of the engineers who have been engaged on the main drainage. This information is all given to the Metropolitan Board of Works, and I do not know that I can give it in a better form than this. I find that at the time of our applying for an additional million, this report was returned to the House as a Parliamentary Paper.

5116. Will you give me the amount of the original estimate in 1858?—£. 2,800,000.

5117. What has it been increased to since that time?—The powers to borrow the sum of 1,115,000 *l.*

5118. Besides the 2,800,000 *l.*?—Besides the 3,000,000 *l.* Perhaps the report will put the Committee in possession of the facts better than anything else: "The original estimates for the main drainage of the metropolis, which formed the basis of the Act for borrowing the sum of 3,000,000 *l.* in 1858, for the execution of these works, were framed upon the then value of materials and workmanship, and were correct and liberal estimates." In confirmation of this assertion, I submit the opinion arrived at by the late Sir William Cubitt and Mr. Robert Stephenson, Mr. Bidder, and Mr. Hawksley, after careful investigation, as published in their official reports. Sir William Cubitt, in his Report of the 3d of October 1853, upon my designs for a portion of the northern scheme, says: "I have most carefully gone over the estimates prepared by the engineer, the prices of which are guided, in a great degree, by the works of the same kind recently executed, and at this time in progress, for the Commissioners, to which heavy percentages are added for contingencies and compensations, for which no exact estimate can be made. The total amount, as shown by the estimate, is 271,290 *l.*; but, reasoning from analogy in similar cases, I strongly recommend that the probable total cost of this measure should not be stated, or at least I do not think myself safe in stating it at less than 300,000 *l.*" And Mr. Robert Stephenson, on the 8th of the same month, reports as follows: "Having read Mr. Bazalgette's report on the subject of an intercepting drain on the northern margin of London, and also Sir William Cubitt's remarks upon it, I have to express my entire concurrence in the views conveyed in both these documents." On the 25th of February 1854, Sir William Cubitt, in reporting upon the plans of Mr. Haywood and myself for the northern drainage, adverts to the estimate in the following terms: "Reverting again to the reports of Messrs. Bazalgette and Haywood, on the interception or deodorising drainage north of the Thames, I can most unhesitatingly state, after a very careful examination of the reports and plans, and the elaborate set of sections and details which they have produced, together with the estimate founded thereon, that the whole are worthy of every attention, as regards the capacities and inclinations of the various intercepting drains in relation to the quantities of water they have to carry and discharge. The whole matter is, in fact, so clearly and minutely set forth in report, plans, and sections, that the engineers have laid themselves entirely open to detection by any person who understands practical engineering, inasmuch as in their present state, the documents would enable such a person to make a correct estimate of the amount at which any portions of the works might be contracted for; a fact highly creditable to the engineers. Nevertheless, as works of this kind, from a variety of circumstances which can form no items in an estimate, are seldom or never completed within even the most elaborate calculations that an engineer is justified in making, I feel bound to state that, although I fully agree with and highly approve the estimate of quantities and probable costs given in the reports now under consideration, I do not think, even if the funds were at once obtainable, that the whole would or could be carried into effect for the sums stated by the engineers; and no blame would attach to them on that account; for there is so much disagreement between the fairest estimates and the ultimate cost of public works of this peculiar nature, so many unforseen items arise, so many inconceivable claims for damages and compensation are preferred both by public bodies and private individuals, that it is totally impossible for the engineer of an immense undertaking of this kind to know and clearly foresee all these contingencies and claims; and could he do so, it would neither be prudent nor perhaps even proper to state them in cases where advantage might be so easily taken both by the public and by contractors to assist them in making out their claims and estimates. I have made the above remarks in order to account for the fact that, although I agree with and approve of the mode of carrying into effect the principle (that of interception) upon which the greater portion of these plans are founded (without giving any opinion upon the principle itself), and although I agree with the estimates of the engineers, as being most fair estimates for carrying into effect the works set forth in the report, plans, and sections, yet I feel it my duty to state distinctly that, in my judgment, the complete establishment of this system of arterial intercepting drains, with all accessories, would not be accomplished for the amount stated in the various reports of the engineers to the Commissioners of Sewers, fair and unassailable though they be; I shall therefore, instead of drawing up a longer report of details upon the various levels, drains, &c. described in Messrs. Bazalgette and Haywood's report of 21st January 1854, advise all persons interested in the measure to read that report and study the tables and estimates thereto appended, which will well repay the perusal, and shall add an estimate of my own as to the probable actual cost of the works therein described, and also of those proposed for the south side of the Thames, including the extension to the Thames in Plumstead Marshes, of which I have already spoken. This will therefore be my estimate for the total cost of a complete system of arterial intersecting drains for the whole metropolitan district," and that estimate is 3,000,000 *l.* On the 15th May following Mr. Robert Stephenson confirmed these remarks of Sir William Cubitt, in the following terms: "Absence from England prevented my uniting with Sir William

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Cubitt in drawing up his remarks, dated 25th February 1854, on the joint report of Messrs. Bazalgette and Haywood on the proposed system of intercepting drains throughout that portion of the metropolis lying on the north side of the River Thames. I therefore now take leave to lay before you a few observations on that report; and before doing so may premise, that it is not my intention to revert to those points touched upon by Sir William Cubitt, as I entirely concur in the opinion he has given respecting the general merits of the plan, and the estimated cost of carrying it out. In 1857 Messrs. Bidder and Hawksley reported with me on this subject, and we then observed upon the probable expenditure of 2,800,000 *l.* as follows: 'Throughout this report we have endeavoured to speak as much as possible in round numbers, easy to be borne in memory. It would be an unwarrantable affectation to employ minute figures in the discussion of a subject which at best only admits of approximations to accuracy. Much of the work under either plan will have to be tunnelled—much must be executed in bad ground and in water, some will pass under buildings and through narrow streets; it is, therefore, impossible to speak with precision of the actual expenses of an undertaking involving so many contingencies and subject to so many casualties.'" I go on to state, that in consequence of the unusually wet summer of 1860, and of the strike amongst the artisans, and of the large number of works going on in and about London, the value of materials rose about 30 per cent. That is gone into and shown very clearly by letters directed to me in 1863, by Mr. Moxon, Mr. Dethick, Mr. Furness, Mr. Brassey, Mr. Harrison, and Mr. Webster.

5119. Then do you mean that the cost of the scheme has already exceeded the estimate of 3,000,000 *l.*?—The works will exceed that amount when completed, but they have not yet exceeded it, the works and compensation together will amount, I anticipate, to the sum of 4,115,100 *l.*

5120. Does that include the low-level sewer? —That will include everything; these letters from Mr. Brassey and other contractors contain bills which they had received and paid for labour and for bricks, cement and other building materials prior to 1858 and since that period, and they confirmed the assertion that the prices of materials rose since 1858 to the amount of 30 per cent., so that an estimate made in 1858 could not be made applicable to works carried out in 1862, 1863 or 1864.

5121. You stated just now the whole of the work was divided into a number of contracts; how many of those contracts were there?—Twenty-three contracts have been let, and three remain to be let.

5122. Are there 26 contracts in all?—Twenty-six contracts in all. As I stated before, with regard to the contracts let, it was my duty to prepare an estimate upon the then current prices, so that I could estimate the value of the works at that time, and to submit that estimate to the Metropolitan Board of Works before the tenders were opened, on the day when the Board met to open the tenders. Before they accept the tenders they require me to put in an estimate of the value of the work; I have given in a return, which I will put in, of my estimates and of the amounts of the lowest tenders; I wish to state with respect to that, that up to 1863, when all the contracts let up to that time had amounted to 2,752,327 *l.* in the aggregate, my estimates for those works were 2,725,983 *l.* I will hand in those estimates to the Committee in detail, and they will see that my estimates on the average approximate to within ·1 per cent. of the whole thing (*the same was delivered in. Vide* Appendix.) I would state that upon my estimate up to the present time, works have been completed or contracts have been let to the amount of 3,069,347 *l.*

5123. How much remains to be let?—My estimate of the contracts remaining to be let is 480,560 *l.*; I should state, at the same time, that those items include a very considerable portion of the compensation for property taken and property injured.

5124. Your estimate of the total amount was 2,725,983 *l.* was it not?—No; that sum has reference to the contracts which were let up to 1863.

5125. Mr. *Tite.*] Can you tell us how many in number those were out of the 23?—Twenty contracts were let. About this time last year, 20 contracts were let to the amount of 2,752,327 *l.*; since that we have let three contracts, which has brought the amount up to 3,069,347 *l.*, and we have three more to let, which will bring it up to 3,549,907 *l.*

5126. Mr. *Ferrand.*] Did that rise of 30 per cent. in the price of materials, take place before or after the contracts were entered into?—It was after one of the contracts was entered into.

5127. Did that make any difference with the contractors; did they receive a higher remuneration?—It ruined that contractor.

5128. Did it not cost the Metropolitan Board of Works anything?—It did not. It applied to one contract amounting to 152,000 *l.*; the rise had taken place between the time of making the original estimate in 1857, and the time of letting the contracts, with the exception of that one.

5129. Dr. *Brady.*] What was the name of that contractor who was ruined?—Mr. Moxon.

5130. *Chairman.*] When do you expect the Main Drainage Works on the north side to be completed?—I expect that the Main Drainage Works on the north side and on the south side will all be completed this year, with the exception of the Low Level Sewer on the north side, which is dependent upon the Thames Embankment; it is now let under contract from the pumping station at the Abbey Mills up to Tower Hill; and the portion between Tower Hill and the new street to the Mansion House has purposely been left out until Parliament shall determine what lines of railways will be constructed through the City, as it is considered very desirable, if possible, that the works should be carried out together with the railways, so as to give as little public inconvenience as possible. From the new street to the Mansion House to Westminster, it is let in connexion with the Thames Embankment, so that what remains to be done is from Tower Hill to the Mansion House, and from Westminster to Cremorne Gardens, and the pumping station at the Abbey Mills and the pumping station at Cremorne. With those exceptions, all will be completed this year.

5131. I suppose that the engines will be of no use till the Low Level Sewer is completed? —The whole of the engines at Abbey Mills will not, but a portion of those engines might be worked to relieve the districts below Tower Hill, which would drain into that portion of the sewage which we are now constructing.

5132. Could they be worked before the Low Level Sewer is completed?—A portion of them might be worked before we get the Thames Embankment completed.

5133. Are you sure that that will be the case?—That it will be so used, I have no doubt.

5134. When will this Low Level Sewer be finished?—The Low Level Sewer cannot be completed until after the Thames Embankment is completed; it will be built up with it; that will be about three years hence.

5135. If I understand it rightly, the result of the Main Drainage scheme is to collect all the sewage at one point on the north side of the metropolis, and to collect all the sewage of the south side at one point on the south side, and then to allow it to flow into the river; the two points for outfall being Barking Creek and Crossness?—I have here a plan which shows the different sewers; there is a pumping station at Deptford, which is not yet complete, but which is in working; the next will be completed this autumn at Crossness at the outfall and the Abbey Mills, and the western division have not yet been commenced; but the sewers of the western division are to be completed within a fortnight. The Middle Level Sewer is completed, with the exception of the aqueduct over the Metropolitan Railway; the High Level Sewer is completed, and we are carrying the sewage now into the reservoir.

5136. What is the area, the base, and the depth of the reservoir on the north side at Barking Creek?—The area is 9¾ acres, and the content is 5,426,000 cubic feet.

5137. What is the depth of that reservoir on the north side?—Thirteen feet and three quarters, or 14 feet.

5138. Are you sure that the contractor has made it of that depth?—Yes.

5139. Have you inspected it yourself?—Yes; I do not mean to say that I measured the depth myself; but our works have been so accurately carried out, that there has not been a quarter of an inch of deviation in levels anywhere, and I have very little hesitation in saying that it was correctly done.

5140. What is the area, the depth, and the cubical contents of the reservoir on the south side?—The area is 6½ acres, the depth is 14½ feet, and the cubical content 4,000,000 cubic feet.

5141. Are those reservoirs to be covered?—They are covered now.

5142. Have you provided for ventilation?—Yes, we have manholes at the top of those reservoirs to let the gasses out; we have men going to work in them.

5143. Will those reservoirs hold those numbers of cubic feet of sewage?—They will. I have here a photograph taken in the Crossness enginehouse which will show the state of the works at the reservoir (*handing in a photograph*).

5144. What is the size of the main sewer which carries the sewage into the reservoir, from the point of conveyance of the sewers on the north side?—I can state from memory that there are three sewers, each nine feet in diameter, and that they are capable of discharging 32,700 cubic feet a minute on the north side. On the south side there is one sewer 11 feet 6 inches in diameter, and it is capable of discharging 19,000 cubic feet a minute. I think we have now come to a point at which I must go into a little description of what quantities of rainfall and sewage we propose to intercept from the Thames, and how those quantities were arrived at, because unless I do so, the Committee will be very readily drawn into some misapprehension on those points. Perhaps the most difficult point that we had to determine in considering the main drainage question was what the amounts to be intercepted should be, first, as regards the sewage, and the mode in which we determined that point was, by taking gaugings of the sewers in dry weather, and ascertaining what quantity each outfall sewer discharged into the river. Taking those gaugings, we discovered that the sewage does not flow at a uniform rate during the 24 hours, but that at times there is more than double the flow for a few hours in the day than there is at other times. At night there is very little flow, and you will readily see that those points will have very considerable effect upon the working of our pumping engines and reservoirs. We found that, although the sewage flows in different districts at a maximum rate for certain hours of the day, those hours vary; but we determined to take the maximum flow of sewage, and to provide in our sewers and pumps, and reservoirs, for that maximum flow; and we also determined to add a considerable per-centage upon that maximum flow for the increase of future generations. And the way in which we arrived at that amount of increase to be provided for, was in this way: we considered that the area was not to be increased, but the population. We found that a number of districts were not fully built on, and we found districts which were closely covered contained a population of about 30,000 to the square mile; and we determined, wherever a district did not contain that amount, to calculate upon that amount as likely to be there at a future time, and to provide for such an amount of sewage in that district. On the south side of the river, the district is not so densely built upon as on the north side; and working the calculation out, it amounted to an increase of about 44 per cent. on the south side, and only 15 per cent. on the north side, together making 23 per cent. increase of population. When we had done that, we had to consider what provision should be made for rainfall; and we found, taking a series of experiments over a number of years, that rainfalls varied very much more than the flow of the sewage; we found that, upon 24 days in the year, the rainfall was less, or amounted to about one one-hundredth of an inch of rain per hour; but then we found that within those 24 days there were exceptional and sudden falls of rain, and that those storms amounted sometimes to 100, 200, and even 300 times that amount.

5145. Did you make any outlets in the main sewers for those overflows to escape into the Thames?—What we did was this: we said, although it is true that this quarter of an inch of rain falling upon the ground does not run off into the sewer, and though a large portion is taken up in evaporation and absorption, still we will provide for taking off in our sewers that quarter of an inch of rain, together with the maximum quantity of sewage; and, making the allowance for future generations and the future increase of population, we provided storm outlets for the surplus

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surplus rain-falls on those 24 days, to flow into the river.

5146. How many of those storm outlets did you provide?—There are some 25, I think, on both sides of the river altogether.

5147. Including both the north and the south sides?—There are about 25 altogether; the outlets of the existing main sewers we have converted generally into storm outlets, so that when our intercepting sewers run full, as they will do when this maximum fall of rain occurs with a maximum flow of sewage, it will flow over weirs into the storm outlets.

5148. For how long would those sewers run full; would it be for 12 hours?—That must depend entirely upon the duration of the storm, but as a matter of fact, storms of that kind are generally of short duration.

5149. Do they last three hours?—Probably not so much; perhaps half-an-hour, in those excessive storms, would clear it all off.

5150. Can you state the total amount of sewage on the north side, including that rainfall, in 12 hours?—I have given you the area of the reservoirs; on the north side the reservoir contains 5,426,000 cubic feet, the daily flow of sewage is 10,000,000 cubic feet in 24 hours on the north side.

5151. Then, in fact, you propose pumping out half of the sewage every 12 hours?—We are dealing with the north side; we have no pumping at the outlet on the north side; we discharge by gravitation.

5152. But if the reservoir on the north side holds only 5,426,000 cubic feet, and the flow of sewage is 10,000,000 cubic feet, how do you propose to make your arrangements?—We propose to discharge into the river for two hours every high water; therefore the reservoir will have to hold 10 hours sewage, which amounts to 4,166,000 cubic feet, and the space left for rain water is 2,519,000 cubic feet in 24 hours.

5153. What is the amount of sewage in 24 hours on the north side?—Ten million cubic feet.

5154. You propose to let that flow into the Thames during two hours?—Yes, for two hours each tide.

5155. What would the flow of the sewage be then, in 10 hours?—Four million one hundred and sixty-six thousand cubic feet.

5156. Did not you state, that in one-third of the day more than half of the sewage flowed?—I think I stated that for a few hours in the day more than half of the sewage flowed.

5157. That would be upwards of 5,000,000 cubic feet in a few hours of the day, would it not?—I do not say that more than half of the sewage flows in a few hours; probably during the maximum flow in the day time you would have more than half that quantity.

5158. How much rainfall do you add for 10 hours?—Two million five hundred and nineteen thousand cubic feet.

5159. That makes 7,519,000 cubic feet in 10 hours, does it not?—Yes.

5160. And the reservoir that is to hold those 7,519,000 cubic feet is only of the capacity of 5,426,000 cubic feet?—I think that I have given you the figures wrong; the content of the reservoir is 5,426,000 cubic feet, and the daily flow of sewage is 10,000,000 cubic feet in 24 hours.

5161. Does not more than half of that flow in a few hours?—I say that it flows at more than double the rate of its average flow; I do not say that more than half of it flows in a few hours.

5162. In your report it is mentioned that more than half of it flows in the first eight hours of the day?—I think that my report says that it flows at more than double the rate, but perhaps it may as you say.

5163. That would give 5,000,000 cubic feet in eight hours, would it not?—Yes.

5164. If you add to that the rainfall in 10 hours, which, you say, is 2,519,000 cubic feet; what would that give?—According to the figures which I have got out, that was the space which was left for the rainfall.

5165. Then what is the rainfall in 10 hours?—The rainfall, taking a quarter of an inch of rain, would be very much more; but I should state, to begin with, that the reservoir on the north side is smaller in proportion than the reservoir on the south side, for this reason, the plan approved of by the Metropolitan Board of Works in the first instance was, that the sewage of the western division should be deodorised at Cremorne, and that the supernatant water should pass into the river at that point; the contract was let for the north side, and the works were half completed, when the Board last year determined to bring the sewage from the western division down to Barking, and I am now giving you the flow of the whole of the northern area, including the western division, and therefore there is not so large a margin left for rainfall; the effect of that will be that during about 70 days per annum, there will be an overflow from the reservoir, supposing that the reservoir is not enlarged (which can be done with great ease from time to time) at other periods than the two hours, when the reservoir is being emptied.

5166. What do you mean by such a space being left for rainfall; do you mean that over and above the amount of sewage there is 2,519,000 cubic feet of space left which the rainfall will fill?—Yes.

5167. The size of the reservoir is 5,426,000 cubic feet, and the flow of the sewage in eight hours is 5,000,000 cubic feet; is not that so?—That is during the hours of the maximum flow.

5168. But if so, it seems to me that the reservoir is not nearly sufficient to hold the sewage and the rainfall?—I think that the reservoir is abundantly sufficient; and I state that if it is not, it can be added to without any additional cost; it is divided into compartments side by side, and we have land, and can add to it at any future time if required; but we are now speaking of what would be required for future generations, and not for the present time.

5169. Do you mean to say that the present flow of sewage is not 10,000,000 cubic feet in 24 hours?—Yes, it is the present flow.

5170. Will you again state what is the average amount of rainfall over the northern side of the metropolitan area?—The average amount of rainfall is 24 inches in a year; but I have provided for very much more than that in my scheme of drainage.

5171. How much is that in 12 hours over the metropolitan area?—I have stated that it varies from nothing up to an inch or three inches in an hour, and that in our system the great difficulty that we have to contend with is as to the amount of rainfall, seeing that it varies so much, and we have fixed the amount which is to be carried off at

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at 1-100th of an inch per hour running off; that is not the fall of rain, and we say that if there were no such thing as evaporation and absorption then the greater part of it would not reach the sewers at the same time.

5172. What is the metropolitan area on the north side?—The total area included in the metropolitan district is 116 square miles; and on the north side it is rather more than half that.

5173. That is above 58 or 60 square miles, is it not?—Yes.

5174. What would a quarter of an inch of rainfall over 60 square miles be?—That requires a little calculation.

5175. That would be the same as one quarter of an inch over 185,856,000 square yards; it appears then that the rainfall taken at a quarter of an inch over the north side of the metropolitan area, will amount to 34,848,000 cubic feet, which you said you "will provide for taking off in your sewers," in 12 hours, will it not?—It would be 7,000,000 cubic feet in 10 hours.

5176. Does a quarter of an inch of rainfall over the metropolitan area on the north side, represent only 7,000,000 cubic feet in 10 hours?—It is so given to me.

5177. How much of that will escape in evaporation and absorption?—About one-half.

5178. In the report of the Metropolitan Drainage, is it not stated to be one-third?—In the subsequent investigation by Mr. Hawkesley, Mr. Bidder and myself, as you will find in the tables appended to that report, it is found that for the heavier rainfalls it amounts to about one-half, and therefore here for the small rainfall it would be probably considerably more; it would be probably about one-third of this running off.

5179. Do you mean to say that two-thirds would evaporate?—Two-thirds would be absorbed or would evaporate.

5180. How much would one-third be?—Two million four hundred and ten thousand four hundred and twenty cubic feet. Before I proceed, I wish to correct another point; in the western division, and in some of the outlying districts of London, which never can be built over closely, and where the proportion of sewage is very small indeed as compared with the rainfall, we have taken one-half of that quantity, and we have provided for one-eighth instead of one-fourth.

5181. Will that make any difference?—It will make a considerable reduction.

5182. What I want to show you is, that the reservoir, according to your own showing, is much too small?—With great submission I think it will be found that it is not so.

5183. If you have 5,000,000 cubic feet of sewage in eight hours, and upwards of 2,000,000 cubic feet of rainfall, putting it even as low as that; how are you to get all that quantity into a reservoir that will not hold as much as 5,500,000 cubic feet?—Of course that could not be done, supposing those figures worked out so. When the sewage and the rainfall have been brought down to Barking, the first overflow would take place at Barking, and the overflow would take place at Barking before it would at the overflow outlets near London, which would all be a uniform and proper system of overflow; but I think that I stated that that reservoir to which we have been referring is smaller in proportion than the reservoir on the south side, and the reason was that it was constructed first to take the sewage without including that of the western division, and then the sewage of the western division was to be carried into it. I believe that it will never be necessary to enlarge that reservoir at all, but if it is necessary it can be done.

5184. Where are the pumping stations situated?—One at Deptford Creek and one at Crossness Point, on the south side of the river; on the north side, one at Abbey Mills and one at Cremorne Gardens.

5185. To what height is the sewage to be lifted at Abbey Mills?—Thirty-six feet.

5186. And how many cubic feet would you have to lift in the 24 hours there?—During the greater part of the day in the greater part of the year at Abbey Mills, there would be 2,900 cubic feet to be lifted 36 feet high per minute, and it will take 197 horse-power to do that; so that at Abbey Mills we shall have one engine capable of working; but then, during the maximum flow, for a few hours of the day, we shall have to lift 5,800 cubic feet per minute, which would take 394 horse-power to lift it; so that, on all ordinary occasions, for say 16 hours out of the 24, we shall have working at the Abbey Mills Station one engine of 197 horse-power, working slowly, taking the sewage, and then, during the eight hours of the maximum flow, we shall increase that working up to 394 horse-power; but, in occasions of heavy rains, we shall have to lift 13,400 cubic feet, and shall work up to 910 horse-power; and we propose to provide at that station 1,140 horse-power.

5187. Are the engines to be in duplicate?—No.

5188. Supposing that one engine breaks down, what will happen?—Out of 1,140 horse-power, as we shall have for three-quarters of the year only some 200 horse-power out of the 1,140 horse-power at work, we shall have a great deal of spare power and capital lying idle, and a great deal of time for overhauling our engines, and therefore it would be very unadvisable to spend our money in providing duplicate engines.

5189. But supposing that any day the engines at Abbey Mills should break down, what would be the consequence?—There would be eight engines making up that 1,140 horse-power.

5190. Then if one broke down, the seven would work on?—Just so; but as a rule we shall have but one engine at work there, and seven will be standing idle.

5191. What description of engines are they; are they Cornish engines?—No.

5192. Who are the makers of them?—They are not made; they are designed only.

5193. You have not set them up?—We have completed the engines at Deptford, and are completing those at Crossness; but at Abbey Mills and Cremorne we are getting out the designs now.

5194. How long will it be before they are set up at Abbey Mills?—I should think that it would be probably two years before they are completed.

5195. Has any one got the contract for those engines at Abbey Mills?—No; the designs are not complete, they have not been advertised.

5196. Who made those engines on the south side?—Messrs. Watt and Company are making the engines at Crossness, and Messrs. Slaughter have made the engines at Deptford.

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5197. What did they cost, either exclusive or inclusive of the buildings?—The engines at Deptford cost 22,300 *l.*, and at Crossness 44,900 *l.*, exclusive of buildings.

5198. What is that per horse-power?—At Deptford about 44 *l.* per horse-power, and at Crossness about 90 *l.* per horse-power.

5199. Why are they so expensive; the Cornish engines are 40 *l.* per horse-power, are they not?—I do not know that Cornish engines are cheaper than the engines that we are using.

5200. Supposing that it had been stated in evidence before this Committee that Cornish engines cost 40 *l.* per horse-power, including buildings, and pumps, and every thing, would not that 90 *l.* per horse-power be very expensive?—We have executed engines at Deptford at 44 *l.* per horse-power, but at Crossness they amount to 90 *l.* per horse-power.

5201. Who made the engines at Crossness?—Messrs. Watt & Company are making them; Mr. Blake represents them. The contract was let by public tender.

5202. Did they tender lower than anybody else?—They were the lowest tenderers.

5203. How many tenders were there?—I do not remember, but I should think probably there were 10 or 12.

5204. What would be the working expenses of those engines per annum?—That must be an estimate, and I cannot give you a very accurate estimate, because the working of them is so uneven.

5205. Have you made any estimate?—I know what the estimate of the ordinary working power of an engine is; it is about 15 *l.* or 16 *l.* per horse-power per annum.

5206. Are the working expenses of those engines dearer than the working expenses of a Cornish engine?—I believe they are. Your Lordship is no doubt aware of the course which was taken with respect to the selection of those engines. I think I should state that the kind of engines to be used for pumping the sewage, and the best kind of pumps to be used, has always been a subject of controversy; the Cornish men advocate the Cornish engines, and others advocate the double acting rotating engines; there is a great difference of opinion; and the Metropolitan Board of Works finding themselves in a difficulty to determine between them, offered a premium for the best kind of engines and pumps, and invited Mr. Robert Stephenson, Mr. Hawksley, Mr. Penn, Mr. Field, and some other gentlemen to select and report upon the best kinds of steam engines to be used for this particular purpose, and they made a report to the Board recommending in considerable detail the kind of engines and pumps that we should use, and we have adopted those ever since.

5207. Were they the best in regard to power, or in regard to smallness of cost?—They were best in regard to power and in satisfactoriness of working, and in their adaptation to small lifts; they have gone very fully, in that report, into the different kinds of engines.

5208. The reservoir on the north side is completed, is it not?—It is.

5209. Has it been long completed?—No; when I say that it is completed, it is practically completed now, but it is being finished off; it is not actually finished.

5210. Has the contractor delivered it?—No.

5211. When was it to have been finished according to the contract?—I think about midsummer of this year.

5212. How much has been paid to the contractor on account?—I am afraid that I cannot give you that; that is in the accountant's hands, and that will be supplied in a return.

5213. Do you know the original amount of that contract?—I think that I stated it at 44,900 *l.*

5214. The contrator has not received as much as 164,500 *l.* on account, has he?—No.

5215. You are quite sure of that?—Quite sure; we will give you that in the return.

5216. Have any of the works included in the contract been omitted?—No, I think not.

5217. Who is the contractor for it?—Messrs. Watt & Company.

5218. Are they the contractors for the reservoir?—I was speaking of the engines.

5219. I will ask you again, when was the reservoir on the north side to have been completed?—The reservoir on the north side was to have been completed by the 31st of December 1863.

5220. It is not quite completed yet, is it?—No.

5221. What was the original amount of that contract?—£. 164,000.

5222. Although the reservoir has not been completed, has not the contractor received already, on account, 500 *l.* more than the amount of the contract, namely, 164,500 *l.*?—I cannot state from my recollection, but that may be so; if so, there are extras upon the contract; but this I can state, that we retained in hand five per cent. upon the whole amount of the contract.

5223. You do not know how much you have paid the contractors?—No.

5224. From those books of specifications it appears that besides those additional quantities of materials that are called "Provisional Quantities" (that is to say, supposing that the contract is to contain 500 feet of wood, you allow the contractor to extend it to 600 feet, at the same price; which is to be paid for if used, and not paid for if not used), there is an amount of loose cash for extra works to the amount of 344,000 *l.*; can you explain that?—Yes. In undertaking any work, in building a house for instance, you cannot foresee all that will have to be done to that house, and it is seldom completed at what you anticipated on first commencing the building of that house. In the case of Main Drainage Works, that applies very much more than it does in the case of a house, and more particularly to a place like the Marshes, where you cannot tell to what depth you may have to sink your foundations, or what precautions you may have to take to protect your works from the tide, and so forth, and, therefore, in all our contracts, we have put down a percentage, varying according to the amount of the contract, to cover unforeseen works.

5225. Are you not now speaking of what you call "Provisional Quantities"?—We put both.

5226. The amount of the contract contains this amount for extra work, does it not?—Yes, it does.

5227. Supposing that there is no extra work done, who arranges whether the sum is to be paid or not?—It is added or deducted according to the schedule of prices.

5228. Are you now speaking of those provisional quantities?—I am speaking of the sum as well.

5229. If the work was estimated to contain 500 feet of masonry it is charged at so much a foot, and if it contains 600 feet you add 100 feet more, according to the same prices; that is a provisional quantity, is it not?—Yes.

5230. But what are those sums for extra work; for instance, in the Northern Outfall Sewer there is 40,000*l.* allowed for extra work?—That is worked, for instance, in laying down the foundations of the piers of the reservoirs; that is measured and added in as an extra. If all those extras amount to 10,000*l.* the contractor has provided for that in his contract, and therefore it includes that; if, on the other hand, that should come to 8,000*l.* it would be a deduction.

5231. Who orders that extra work to be done?—If it is of large amount, the Board order it; if there are minor items, I order them, and if they are smaller still, then the assistant engineer orders them.

5232. Supposing you had not actually ordered the extra work, would that sum of 40,000*l.* be subtracted from the contract?—Yes, it would.

5233. Have you in any cases subtracted these extra works?—Yes, we have.

5234. Up to 1862 they amount to 344,000*l.*, do they not?—Yes; that is about 10 per cent.

5235. How much of that have you subtracted from the contract—Our contracts are not sufficiently settled for me to say that; but I am afraid that there will not be very much; in most cases our estimates are exceeded, though not in all.

5236. In contract, No. 1, for the Thames Embankment, it is 70,000*l.*; is there none subtracted from that?—No; that cannot be done until you come to measure up the work. The clerks make a weekly return which they send in to the engineer, and which is recorded; and when we finish up the work, we work those returns out, and make our additions and deductions. It goes through the accountant's hands in the regular form.

5237. Who is the contractor for the reservoir on the northorn side?—Mr. George Furness.

5238. Was his tender the lowest?—No; I think not. Mr. Baylis's tender I think was the lowest.

5239. Was there another lower than that?—Yes; I think there was another between, there were two lower than Mr. Furness's, but I am speaking now from recollection.

5240. Were there three lower?—I do not remember.

5241. Why, supposing there were two or three lower, was Mr. Furness's tender taken?—I can only state that from recollection; there may have been other things. I think that the inquiries with respect to some of the contractors made by the Metropolitan Board of Works, were not satisfactory with reference to themselves or their sureties; and I think that another withdrew himself upon the ground that he had since obtained works on the continent.

5242. With regard to the Low Level Sewer, who has got the contract for the first section of that?—Mr. William Webster.

5243. Is it not Mr. Furness?—No.

5244. Has he got the contract for the second section?—No, he has not.

5245. Is not that first contract for the Low Level Sewer let to Mr. Furness?—Yes.

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5246. Was his the lowest tender in that case?—It was not.

5247. How many were there lower?—Two or three.

5248. Do you know whose was the lowest?—Mr. Ridley's, I think.

5249. Do you remember what was the amount of his tender?—I do not.

5250. Do you remember what was the difference between his tender and Mr. Furness's?—No.

5251. Was it 25,000*l.*?—I think it was thereabouts.

5252. Why was Mr. Furness's tender taken in that case, and not Mr. Ridley's?—I think that perhaps I should hardly answer that question; it was a matter discussed by the Board, and for reasons, which they deemed sufficient, they thought it more prudent to take Mr. Furness's than Mr. Ridley's; I think that it would be rather out of place for me to divulge those reasons here.

5253. Would it be a breach of confidence?—I think it would.

5254. You gave us the reasons in the case of the reservoir; was that also a breach of confidence?—I do not think that I have gone into the reasons; but to the same extent I can give you the reasons why Mr. Ridley's tender was not accepted.

5255. Will you tell us the reason?—I can state, as I did with respect to the other, that the Committee were not satisfied after the inquiries which they made.

5256. Was not Mr. M'Cormick the Member for Londonderry, associated with Mr. Ridley in that contract?—Mr. M'Cormick sent in the highest tender but one, I think.

5257. Mr. Ridley's tender was the lowest, being 495,000*l.*?—Yes.

5258. Did not Mr. M'Cormick say that he would associate himself with Mr. Ridley at Mr. Ridley's prices?—He did; but I think that I should follow that up by saying that Mr. M'Cormick was asked how he accounted for knocking 100,000*l.* off his tender, and he stated that it was on account of his having estimated for a peculiar kind of cofferdam; he was asked by the Chairman of the Metropolitan Board of Works if he was prepared to put in that kind of cofferdam if he joined Mr. Ridley, and he answered, certainly not.

5259. I wish to ask you a question with regard to a statement which has been made by a member of the Metropolitan Board of Works, which you are at liberty not to answer if you prefer it; it has been stated, that you were to receive a commission from Mr. Furness of 12,000*l.*, with regard to some Odessa works; is that true?—That is quite true.

5260. Have you received that commission?—No.

5261. Is it pending in Chancery?—It is; but I have withdrawn from the suit.

5262. Why have you withdrawn?—I withdrew in deference to the wishes of the Board of Works, because it might prejudice me in other matters, and as engineer to the Board of Works.

5263. Had not any contract been given to Mr. Furness before it was brought before the Board?—Mr. Furness was a contractor of the Board of Works.

5264. You state that you reported on every tender

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tender before it was opened?—I gave an estimate.

5265. And were you not consulted about the tenders?—Yes.

5266. And Mr. Furness received contracts from you before you refused to receive this commission of 12,000 *l.* from him; was that so?—He received contracts from the Metropolitan Board of Works; I should state that, although I was to receive the commission, and that commission was to come from Mr. Furness, that was by an arrangement between Sir John Rennie and myself; I had nothing to do with Mr. Furness and Sir John Rennie; but the facts of the case, which have been made public, I believe, are simply these, that Sir John Rennie had obtained a concession for some works at Odessa, and Sir John Rennie wished to find a contractor to carry them out upon the terms of that contract, paying him the sum of five per cent.; Sir John Rennie did not succeed in getting a contractor; and, after many conferences with me, he said, "If you will find a contractor willing to take the work I will divide the per-centage with you." It is true that that per-centage had to be paid by Mr. Furness, the contractor, but I had no agreement with him, and, whether he was the contractor for my works or any other works, would not have affected my position with the contractor at all; it was a thing done for his benefit; it was the sale of a concession which Sir John Rennie and myself became possessed of.

5267. Mr. *Tite.*] I understand that the original estimate for the metropolitan drainage was 3,000,000 *l.*, in round figures?—It was.

5268. Was not that the result of the report of certain engineers who acted with you in that matter?—It was.

5269. Then you found last year that that sum was too little, and you made the report of which you have read a portion, omitting some very important portions; that matter was brought before the Chancellor of the Exchequer and before the House, and an Act of Parliament was passed to enable the Board of Works to obtain the additional amount?—It was.

5270. You have forgotten, have you not, that that additional estimate was largely caused by the Cremorne works being altered?—That was one reason of the increased cost; and another reason, which I have not stated, was the amount which has become payable for easements.

5271. You suggested also the additional cost of the land required for those works, is that so?—Yes; for the interference with property and for the land required there is an additional cost.

5272. And the consequential damage?—Yes.

5273. In the increased estimates which you have given, are the increased cost of the land and the consequential damage included?—Yes; that, we believe, will complete the main drainage works entirely.

5274. With regard to the northern side, there are three sewers, the Upper Level Sewer, the Middle LevelSewer, and the Low Level Sewer; is the Upper Level Sewer completed?—It is quite completed.

5275. And is the sewage from it going by natural accidence into the Thames at the present moment?—It is; it is flowing now from Hampstead and Highgate over the River Lea, through the Outfall Sewer into the reservoir at Barking Creek, and is discharged into the compartments of the reservoir, which it fills, and it is discharged at high water into the river, never returning to London.

5276. In what state is the Middle Level Sewer?—A considerable portion of the Middle Level Sewer has the sewage flowing into it; it is completed, with the exception of an aqueduct over the Metropolitan Railway, and when that aqueduct is completed in the course of six weeks or a couple of months, the whole of the Middle Level Sewer will be finished, and the sewage will be flowing out at Barking.

5277. Will that sewage require to be lifted?—No, it falls by gravitation; then the western division we shall have completed within a few weeks, and we are putting up temporary pumping engines, which we have removed from another outlet so as to lift the sewage, and give that district, which is very low, relief until the Low Level Sewer is completed.

5278. That will eventually come into the Victoria Sewer, and go along the Thames Embankment, will it not?—It will.

5279. Will it be pumped?—It will be pumped at Abbey Mills, and so lifted.

5280. And therefore we shall have two sewers completed on the north side, and the third must wait until the finishing of the Thames Embankment?—Yes, that is so, and if you look at the map you will find that these two systems of sewers, with the western system, take nearly the whole of the drainage of the northern area, and it is only a narrow strip from Piccadilly running up to Oxford-street and to the Strand that will be left.

5281. Taking a similar operation on the south side of the river, what is the extent of finished working there; is the Upper Level Sewer finished?—The Upper Level Sewers are finished, and the Bermondsey branch, which is a very important part of the work, is finished; and the Low Level Sewer itself will be finished about the end of the year; the Deptford pumping station is practically completed. I should like to mention that we have four engines there, each of 125 horse-power. We have, I think, about half of the sewage of the south side now coming down to Deptford, and we have one engine working at half-speed, which takes the whole of the sewage that comes down, and we have to wait three or four hours a-day because she has taken all the sewage, and there is nothing more for her to work at. Then the Outfall Sewer on the north side is completed, and the reservoir and the Outfall Sewer on the south side, from Deptford down to Erith Marshes, has been completed a long time. The reservoir is drawing towards completion, and the engine-house, of which I put a photograph on the table showing the state of the works, will be completed this year.

5282. Will the works on the south side be altogether completed this year?—They will be altogether completed this year.

5283. Excepting what is called the Lower Level Sewer on the north side we shall, this year, see all the works completed; is that so?—Yes, I fully anticipate that.

5284. Of course the quantity of sewage and the quantity of water is the basis of all the arrangements that have been made?—That is so.

5285. Were those reasons which you have suggested at some length reasons which were sanctioned and gone into by other engineers besides

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besides yourself, to whose names you have adverted; are the calculations derived from the original reports? — Yes; they have been the subject of very long experiment and discussion from time to time, and they have been controverted and supported by various engineers, and finally adopted and determined upon.

5286. I gather from you that you think that the reservoir at Barking Creek is small in proportion to the averages which have been spoken of, by reason of the Cremorne sewage being now turned into it; is that your opinion?—Yes, it is; but I think that it would be unwise to add to that reservoir at the present time, for I think it will be found that, for many years to come, it will answer its purpose most fully.

5287. With regard to this contract upon which you hesitated to give all the information that was asked for, that is, as a matter of course, discussed in confidence in the Committee to which it is referred?—Those matters are determined by the Committee.

5288. And they are reported upon finally to the Board?—Yes.

5289. Therefore, that is their doing and not yours?—Yes.

5290. With regard to the question as to the commission, and your dealings in the case of the Odessa contract, which has been explained, is not that a matter which has been brought before the committee of the Board of Works?—Yes.

5291. You withdrew from that matter at a very early period of the discussion, did you not?—I did.

5292. That was money, in point of fact, to be paid to Sir John Rennie through the contractor who got the works, the understanding being that Sir John Rennie was to have five per cent., and that you, having helped him to find a contractor, he was to divide half that commission with you? — That was so.

5293. Have you ever received one shilling from it?—Never.

5294. However, be the matter what it may, it is before the Committee and before the Board of Works, is it not?—Yes, fully. It never affected my position with Mr. Furness in the slightest degree.

5295. The noble Chairman is quite right in suggesting that there are rods of brickwork and yards of concrete provided for over and above the contracts?—Yes.

5296. And in addition to that, there is a sum of money provided, is there not?—Yes; to be applied in extra works.

5297. What is your habit as to the works; is the work all duly measured up every month, and do you report to the Board the sum of money which is due to the contractors?—It is not measured by myself, of course, but it is measured up by assistants, with proper checks, and the assistant engineer comes to me with the prices and valuations marked up, and we take together the value of certain portions of the works which do not depend upon measurement, always taking care to be on the safe side, so that, if the contractor should break, the Board may not lose by it.

5298. How many sub-engineers and clerks of the works have you for all those works?—I have three sub-engineers, two on the north side and one on the south side, and a very large number of clerks of the works.

5299. They are not paid by you, are they?—None of them; they are all paid and appointed by the Board; the three sub-engineers, practically, do that portion of the work, as my time is taken up during a great part of the year in attending the meetings of the Board, and attending before Parliamentary Committees, and so on.

5300. Mr. *Ferrand.*] You stated that the area of one of the reservoirs was 9¼ acres, and that the contents was 5,426,000 cubic feet; you were asked by the noble Chairman whether you could vouch for the accuracy of that content, and you stated, did you not, that you had not measured it?—I did.

5301. Who has measured it?—The assistant engineer.

5302. Who is he?—Mr. Cooper.

5303. Has he delivered in his report to you?—He does report to me.

5304. Has he reported?—From time to time he has.

5305. The statement by the noble Chairman, as I understand it, is, that it has been intimated that this reservoir is not of the size stated by you; I therefore wish to learn from you, whether your sub-engineer has delivered in to you any statement, in writing, of the real size of that reservoir?—He has certainly not delivered to me any statement to the effect that that reservoir is not executed according to the contract drawings, nor do I conceive it to be possible that it could be executed otherwise, because it would alter the whole design; the number of piers are measured out, and set out accurately from centre to centre, and I should detect any alteration at once by the eye, in going over it; any alteration in that reservoir pre-supposes and involves a system of fraud amongst the whole of the establishment of the Metropolitan Board of Works, which cannot exist.

5306. We have nothing to do with what it involves, but what we want to know is, whether there can be any truth for a statement which has gone abroad, that this reservoir does not contain the quantity of sewage which it is stated by you that it does contain?—I am quite prepared to answer for its holding what I have stated.

5307. But can you do that, if it has not yet been measured?—I can do it from having made so many inspections of the reservoir myself; and from the knowledge that if it will not hold that quantity, there must have been some grave and serious departure from the contract drawings, which I should have detected in looking over it.

5308. Are the Committee to understand that you measure this reservoir by the eye when it is completed, and not by proper measurements?—It is measured properly; but it is not yet measured.

5309. If it is not measured, when is it to be measured?—The works are set out by our clerks of the works with a system of checks, one checking the other.

5310. Are we to understand that the sub-engineer, whose duty it is to measure this reservoir, has not yet measured it?—I have no doubt that he has measured it over and over again.

5311. When he has measured it, does he deliver in a statement to you as the principal engineer?—He will not deliver in his measurements of the quantities to me until we come to settle the contract.

5312. Then the reservoir is not finished yet, is it?—It is just on the point of being finished; it is, as I stated, practically finished.

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5313. How long ago was it practically finished?—It has been practically finished for the last six weeks.

5314. Then your reason for not knowing what the real extent of that reservoir is, is that you have not yet had sufficient time to measure it?—I know that it is of the extent which I have stated, and that what I have stated is correct; I know that it is carried out according to the contract drawings, and that the measurements which I have given you are correct.

5315. Then, as the engineer, you pledge your word to this Committee that it will contain that quantity of sewage?—I do.

5316. You were also asked as to the cost of the engines, and you stated, I think, that they were made by Messrs. Watt & Co.?—Yes.

5317. Were they made by public contract?—They were.

5318. Of course, it rested with the Board of Works to decide as to who should be the contractor; have you any knowledge as to how many competitors there were?—I do not remember accurately, but I think perhaps 10 or a dozen.

5319. Was Messrs. Watt's tender the lowest?—I think so.

5320. *Chairman.*] Did not you state, in answer to a question which I put to you, that theirs was not the lowest?—I think that that had reference to the reservoirs; I understood the Honourable Member for Devonport to be speaking with reference to the engines; I am told that there was a lower one, but that he would not undertake some responsibility.

5321. Mr. *Ferrand.*] How many engineers are employed by the Board of Works?—I have three assistants.

5322. You are the chief engineer, and you have three subordinates under you, is that so?—Yes.

5323. How are you paid for your services, and how are the three sub-engineers paid?—We are paid a salary by the Board.

5324. Have you any per-centage on the guarantees, either yourself or the sub-engineers?—No.

5325. Are you sure that neither yourself nor the sub-engineers receive any commission or any other allowance whatever from the contractors?—Quite sure.

5326. Dr. *Brady.*] You state, do you not, that the engines were first contracted for by specifications being sent out?—Yes.

5327. Mr. *Tite.*] Did not the Board of Works advertise for schemes of engines of all sorts and kinds?—Yes, I stated so.

5328. You referred those schemes to the several engineers of whom you have spoken?—Yes, as I have stated already.

5329. Dr. *Brady.*] Was anything said with regard to Cornish engines in the specifications?—No.

5330. Was it left open?—No, nothing was left open; but I explained that in the first instance, by saying that there was a great difference of opinion as to the kind of engines that should be used: the Board of Works advertised for different designs for engines, and they then appointed a Commission, consisting of Mr. Robert Stevenson, Mr. Hawkesley, Mr. Penn, Mr. Field, and some others whose names I cannot recall at this moment, to report to them upon those designs, and further to state what was the best kind of engine and the best kind of pump to be applied under the conditions required for the sewage of London. These gentlemen made a report, recommending the engine which we have adopted; and we have followed out that report, and have made designs for engines, and drawn specifications of the way in which they are to be constructed; and then we have said to the engine builders, "What will you build us an engine according to that design for"? they have sent in their tenders, and we have, as a rule, taken the lowest tender.

5331. The Cornish interest was not represented on that Committee; there was no gentleman on that Committee from Cornwall, was there, who had been in the habit of using those engines?—I really forget what the names were; but I know that the question of Cornish engines was very fully discussed.

5332. But in your advertisement, after having made the specifications, the Cornish engines are wholly excluded, are they not?—An engine, according to a certain design, which is not a Cornish engine, is required to be built in carrying out the suggestion of the authorities whom I have quoted.

5333. Did you not state that Cornish engines were worked at a lesser expense than those which you are using?—I do not think I stated that. I really have had no experience in the working of Cornish engines.

5334. You stated, at all events, that they were cheaper?—I think I did not say that.

5335. Did you not say that one cost 40 *l.*, and that the other cost 90 *l.*?—I said that, neither of them being Cornish engines, the engines at Crossness cost 90 *l.* per horse-power, and that the engines at Deptford cost 44 *l.* per horse-power, they being the same description of engines.

5336. Then you cannot state to the Committee what would be the cost of Cornish engines?—No; I cannot state that.

5337. I think you stated that you always made an estimate for the Board of Works when contracts were advertised for?—I did.

5338. And you made this estimate upon the same day on which the contracts were received?—I did; before the tenders were opened.

5339. In the specification which I have before me, in which you laid down the provisions for a coffer-dam next the River Thames at Barking Creek, did you make an estimate as to what would be the price of that coffer-dam at the time?—No, not specially. I put down a per-centage for contingencies.

5340. But did you, in the estimate which you gave to the Board of Works, include that coffer-dam?—I put down a per-centage to cover it.

5341. What might be the expense of that coffer-dam?—I cannot tell you off-hand.

5342. Would it be 20,000 *l.*?—I should think it would be much less than that, but I do not like to state the amount, as it would be merely a guess at the present time.

5343. How much less would it be; would it be 16,000 *l.*?—No, I should think not; nothing like it.

5344. Would you be kind enough to say what it would be?—I should suppose it would not be half that, but of course I cannot give an estimate for a coffer-dam without knowing the extent of the coffer-dam.

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5345. Would it be 10,000 *l.*?—I should think not.

5346. Would it be 8,000 *l.*?—Possibly it might be. I think that probably it would be somewhere there about.

5347. Has there been a coffer-dam made at the outlet by Mr. Furness?—Yes; there has.

5348. In what position is it?—Outside his works, to protect them in the river. It really was a question as to whether it would be better to form a coffer-dam outside the works, or to put protecting work inside; and therefore it is not the whole difference of 8,000 *l.* to the contractor; and I think he himself made choice of a coffer-dam outside. I do not know how that was.

5349. But in this specification you have specified that the coffer-dam should be made in such and such a way; has that coffer-dam been made in accordance with those specifications?—I do not think that that coffer-dam is described in the specifications.

5350. Here is the description, "Provisions for coffer-dam next river Thames and Barking Creek;" has that been made according to the specifications?—The mode of doing it is not described, I think.

5351. It is thus described; it is "to extend 50 feet at each end beyond the excavation for the reservoir, both next the River Thames and Barking Creek, and the contractor will be held wholly and entirely responsible for the proper maintaining and keeping up and in repair such river wall to the satisfaction of the Conservators of the River and Commissioners of Sewers of the Marsh Level, during the execution of and for 12 months after the completion of the works;" is that done?—Yes, it was done.

5352. In the contract for the Thames Embankment I find that there was a specification sent out on account of that; was that so?—Yes.

5353. The clause is this: "For the purpose of providing gravel, sand, soil or other materials for the embankment and works, the Conservators of the River Thames may, under the 16th section of the Thames Embankment Act, 1862, when required by the Board, raise from the bed of the said river such gravel and other matters, and the same are to be deposited in such places as the Board shall designate," and so on. This clause provides that all the embankments of the Thames should be made from the sands of the river, and that the Thames Conservators should be ready and willing to grant it, and therefore all parties sending in contracts laboured under the impression that they should have to use this material for the making of the embankment; is not that the case?—Yes, that is so: that specification does not provide that it must come from the Thames.

5354. It provides that it shall, and that if it cannot be got thence it shall be got elsewhere; has there been any difficulty in getting it from the Thames?—I believe there has.

5355. With whom has the difficulty arisen?—I believe that the Conservators have not supplied sufficient quantities for the contractor to get it.

5356. Have the Conservators failed to supply him?—I believe they have.

5357. Are you quite certain of that?—No, I am not.

5358. Are you aware that the embankment is not being made with the sand of the Thames?—I am; it is being made partly with clay and other materials from the land.

5359. Are you not aware that it is being made by rubbish which is collected from all parts of London?—Not rubbish, clay, and so on.

5360. Are you not aware that the present contractor is receiving a sum of money from other contractors, from 8 *d.* to 1 *s.* a load?—I have heard that as a rumour.

5361. Looking at that, do you not think that it would have been proper, before this specification went out, that some provision should have been made in it that a similar course to that which is now pursued by the contractor might be allowed to be pursued by other contractors?—When that specification was drawn it was drawn by the Board after a great deal of communication with the Thames Conservators upon that point. The Thames Conservators seemed to consider it very important that all the material for the Thames embankment should be taken from the River Thames, and we therefore drew that clause in conjunction with them, requiring the contractor to take it from them, provided they gave it to him of good quality. When we started that contract I imagined we should have it all from the Thames. I have inquired on the works frequently how it is that they do not take the material from the river, and what the Conservators say to it. Indeed I have spoken of it to the engineer of the Conservators, but the contractors tell me that the Conservators do not supply material fast enough, and that they are taking it from other sources as well. If the Conservators objected, and said that they could give more material, and that we were not taking it, I should at once require the contractor to take it from the Conservators; but I do not conceive it to be part of my duty to stop the works so long as the Conservators are not supplying the necessary quantity.

5362. What sort of stuff is this material which is obtained from the land?—Clay and brick rubbish.

5363. Would it not have made a very material alteration in the price of the contract if other contractors had known that they could have put in that rubbish, and could get 8 *d* or 1 *s.* a load for it in place of putting in sand?—No doubt; but I was not prepared to tell them, nor was the Board of Works prepared to tell them, nor would they tell them so now, and it may be stopped any day.

5364. Is not this rubbish, to a large extent, being washed into the River Thames?—No, that point I have paid attention to. I have found that the ballast which is dredged from the Thames, which was of a muddy description, and which was deposited from barges and taken away, created a great deal more mud in the river than the way in which we are doing it now, nor would it make, I think, so good an embankment.

5365. Mr. *Tite.*] But if there is any economy, will not the public have the benefit of it?—The contractors get the benefit of it.

5366. Mr. *Brady.*] Are not other contractors deprived of the advantages of being able to put in their contract the sum of money which they could do it for?—I am quite sure that if the Conservators were to say, that we are not using all the ballast they were able to give us, and that they required us to use more, the Board of Works would tell the contractor to stop using this stuff, and to take it from the Conservators.

5367. One contractor has sent to you an estimate for a contract, and he estimated it at 59,877 *l.*; if he had known that he could have put

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put in this rubbish, do you suppose that he would have given so large an estimate as that?—Nobody could have known it at the time; I believed, and everybody believed, that he would have to use Thames ballast, but up to the present time, they have used some other materials.

5368. Is it true, that estimating the loads of rubbish which he is throwing in, it will amount to a saving of 20,000 *l.*?—I have not the least idea of what it will amount to; I do not know the terms upon which they are getting it at all.

5369. In the report about the Odessa affair, which his Lordship has spoken about, there was a report made by the Board of Works, was there not?—There was.

5370. In that report, was there not some reference to the contracts which had been sent in?—Yes.

5371. Is it not stated in that report that the reason why the Board of Works gave the contract to Mr. Furness was from the fear of the bridges giving way, and from other causes, and because his experience was so great, beyond all others, in such works?—I do not think that it states that.

5372. I assert that it does state so. Will you tell me what works Mr. Furness had done in that line before?—I really cannot recollect what works he did.

5373. Did he ever do such works before?—I know such works were stated to the Board at the time.

5374. Can you name any one of such works?—No; I am not aware of the names.

5375. Are you aware that Mr. M'Cormick, in his letter to the Board of Works, stated that he was prepared to join Mr. Furness in carrying out the contract?—Yes.

5376. Are you aware that the difference between the contracts was 25,000 *l.* in favour of Mr. Furness?—Yes.

5377. Then if we take this 20,000 *l.* which is saved by the carting of this rubbish, and the 25,000 *l.* by which one estimate exceeded the other, that would make a large item, would it not?—Twenty thousand pounds saving on the carting is an imaginary sum, which I know nothing about.

5378. But there is a certain quantity of space to be filled up, and the contractor receives 8 *d.* or 1 *s.* a cart load, does he not?—He is supposed to complete the whole embankment.

Jovis, 30° *die Junii*, 1864.

MEMBERS PRESENT:

Mr. Caird.	Lord Robert Montagu.
Mr. Cowper.	Mr. North.
Lord Fermoy.	Sir Joseph Paxton.
Mr. Ferrand.	Sir Frederic Smith.
Mr. Hibbert.	Mr. Tite.
Mr. Leader.	

LORD ROBERT MONTAGU, IN THE CHAIR.

WILLIAM M'CORMICK, Esq., a Member of the House; Mr. SAMUEL COKES RIDLEY; and Mr. JOSEPH CLEAVER, were called in; and Examined as follows:

W. M'Cormick, Esq. M.P., Mr. *J. S. Ridley*, and Mr. *J. Cleaver*.

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5379. *Chairman.*] (To Mr. *Ridley*). You are a contractor, of many years' experience, are you not?—Yes.

5380. Whom was it that you employed to make your calculations, previous to putting in your tender for the first portion of the Low Level Sewer and the embankment over it?—Mr. Cleaver, together with Mr. Stephen Sewin, of Boston.

5381. (To Mr. *Cleaver*). You are a measuring surveyor, of some years' standing, are you not?—I am.

5382. Were you employed by Mr. Ridley to make the calculations, and an estimate, for the cost of the works for the first portion of the Low Level Sewer?—I was.

5383. Did he make his tender upon your estimates?—He did.

5384. (To Mr. *Ridley*). Your tender for the Low Level Sewer, and the embankment that covers it, was the lowest, was it not?—It was.

5385. To how much did it amount?—It was 600 *l.* below Messrs. Baker and Son, the Government contractors.

5386. Messrs. Bakers' tender was 495,600 *l.*, was it not?—I think that that was the amount.

5387. What was the next one above Messrs. Bakers'?—I almost forget, just now, what the amount was; but I think Messrs. Moxon and Company were the next.

5388. Was their tender 510,076 *l*?—I forget the exact amount, but I have no doubt that it is so.

5389. Who came after Messrs. Moxon?—Mr. Furness.

5390. What was his amount?—520,000 *l.*, I think, was the amount.

5391. You were declared the contractor, were you not?—I was.

5392. Did the Board raise any question as to your sureties?—They did.

5393. What was that question?—There was an objection to one of the sureties.

5394. The amount of the security was 20,000 *l.*, was it not?—Yes, the amount was 20,000 *l.*

5395. Mr. *Tite.*] For each?—No.

5396. Jointly and severally?—Yes.

5397. *Chairman.*] Did your solicitors write to the solicitors of the Board saying that you were ready to deposit the amount of your security, namely 20,000 *l.*?—They did.

5398. That was the full amount to which your sureties were bound?—It was; but I may say that after I was accepted on the Friday, a person from the Board of Works met me on the Monday morning after, and asked me who my solicitors were, and who my sureties were, and who my bankers were, and several other things. I referred him to my broker, and my bankers, and my solicitor, and then they entered into negotiation with the solicitor.

5399. Who was that person?—I do not know his name; I understood that he was a man whom the Board of Works sent round to make enquiries.

5400. What did he say?—He said that he was authorised by the Board of Works to make enquiries; he asked me who my bankers were, who my solicitors were, and what works I had done before, and I referred him to several people, Messrs. Rixon and Son, and Messrs. Fowler, Hargrove and Blind, who were the two solicitors who had acted for me in what I had done in England; they went to Mr. Hargrove, and he at once came to me and said that the Board of Works required explanations.

5401. Was that after or before?—It was about the Tuesday after I was declared the contractor.

5402. Did the Board raise any objection to your practical experience?—I understood that they did. As far as my sureties went, I not only offered to put down the 20,000 *l.* as my surety, but I offered two good men; I sent in two more sureties.

5403. Did you enter into an arrangement with Mr. M'Cormick, the Member for Londonderry?—I heard then that they were quite satisfied with my sureties, and the next thing was the attack upon me for not having done the same class of work in England. I said, "Nobody has done that class of work in England, but to strengthen myself, I will associate myself with Mr. M'Cormick who I am informed has had more experience than any contractor in England;" he was then in Derry, and his engineer sent him a quantity as if two coffer-dams were required, and, consequently, Mr. M'Cormick's tender was 100,000 *l.* higher than mine. When I applied to him, he said that his engineer had made an enormous mistake, and he said that he never should have sent in the tender as it was, had he been in London instead of in Derry. I thought he meant to kick me out of the work, and I asked him whether he would join me; we compared the tenders, *W. M'Cormick*, Esq. M.P., Mr. *J. S. Ridley*, and Mr. *J. Cleaver*.

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and there was not 4,000 *l.* difference in the whole amount, except in the coffer-dam; he had calculated for two instead of one, and he said he would join me.

5404. Did he say that he would join you on your prices?—Decidedly; and he at once wrote a letter to the Board to that effect. The Board had a meeting upon that, and I heard that there was a great discussion upon it, and Mr. M'Cormick was ordered to meet the chairman and Mr. Bazalgette a day or two after; I accompanied him to the office, and I was not called in. When Mr. M'Cormick came out, he said, "Those fellows mean you no good; they put some queries to me, and they do not intend to give you that job;" I said, "What are the conditions?" He said, "They want me to put down some peculiar coffer-dam; I submitted a plan which I have worked for 20 years at Birkenhead and different places, and to put an iron dam is impracticable for the money; however, I told them that if they would give me a sketch of what they wanted, I would give them an answer in an hour, or something of that kind." The plan that he proposed was what he had been working on, and had spent a great deal of time upon, and he had got the most experienced people in the country, that had done works for 40 years and more, and paid them for their tracings, and so forth. That plan was the plan that Mr. M'Cormick, I believe, left with the chairman of the Board.

5405. After you had been declared the contractor, and all this had happened, was not the contract granted to Mr. Furness?—After the interview with Mr. M'Cormick we neither of us heard anything more about it until we attended at the next meeting, expecting to be called in; we were not called in, but we heard that Mr. Furness was declared the contractor.

5406. His tender was for 25,000 *l.* more than yours, was it not?—25,000 *l.* more than my tender, and Mr. M'Cormick agreed to join me in it.

5407. Did you tender for the outfall reservoir, on the north side?—Yes.

5408. Mr. *Tite.*] Was that before or after this?—Previous to this.

5409. *Chairman.*] Was your tender the lowest?—It was not; Messrs. Hickersley and Baylis's was the lowest.

5410. What was their tender; was it 131,000 *l.*?—I think it was somewhere about that.

5411. Who got the contract in that case?—Mr. Furness.

5412. What was his tender?—I think it was 164,000 *l.*

5413. Is the work under that contract completed?—I believe not.

5414. Mr. *Tite.*] You have not seen it?—Yes; I saw it last week.

5415. *Chairman.*] Was it finished then?—It was not finished.

5416. Are you sure of that?—I am positive of it; there were a great number of men working about it, and I think that there is a good deal of brickwork to be done.

5417. I understood Mr. Bazalgette to have stated that it was finished; but you are quite certain that it is not?—It is not finished.

5418. Do you know how much has been paid to Mr. Furness on account of that contract?—I only know by what I read in the papers, and the Report of the engineers.

5419. Has he been paid 500 *l.* more than his contract?—I cannot say; I only know that by rumour.

5420. What was the depth to which the foundations of the northern outfall reservoir were to have been carried, as stated in the specifications?—I cannot remember how far it was; there were plans and specifications, and a section given.

5421. Cannot you state the depth to which the foundations of the northern outfall reservoir were to have been carried?—I cannot remember exactly; I have heard Mr. Eckersley say (but of course it was only rumour) that they were not taken down to the depth shown on the plans. I said to him, "How came you to be so low for that job?" He said, "We were pretty well aware that the detail drawings would not want to be carried out; in the first place, they would not want us to go so low in the calculations, and a certain coffer-dam, which I think I put down 16,000 *l.* for in my tender has never been done." I said, "I think you and I have been treated very hardly about it; how was it; could not you give good security?" He said his father became security for one and Mr. M'Cormick became security for the other man; it is ridiculous for the Board to object to Mr. M'Cormick for the sake of 5,000 *l.*

5422. In the specifications for these works, was the contractor bound to make a coffer-dam?—That was at the engineer's option.

5423. He might, or might not?—He might, or might not; to the best of my memory, that was how it was.

5424. How much did you estimate the coffer-dam at when you put in your tender?—I cannot say from memory; I think it was 16,000 *l.* Mr. Cleaver did not help me to make up that estimate.

5425. Has such a coffer-dam been constructed?—I believe not.

5426. Do you know?—I was down the other day, and I could not see anything of it; and I was told by one of the men on the works that it had not been put in. There has been a dam put in there, at the outfall, where the big sewer lets the water into the river; but not this coffer-dam; that is entered in the specifications.

5427. Mr. *Tite.*] What was it for?—It was supposed that, in the event of the foundations going down a great depth, the embankment might not be strong enough to keep the tide out, but it was to be left subject to the engineer.

5428. Mr. *Ferrand.*] Would that dam be as expensive as the coffer-dam?—That is the coffer-dam.

5429. Will it cost 16,000 *l.*?—Yes.

5430. Would this little dam that is made at the outlet of the sewer cost as much money in making as the coffer-dam?—Those are two distinct things; it is not the same contract; it is quite a different contract; I did not tender for the first at all. This was the reservoir, and the other was the sewer; the reservoir coffer-dam, I am told, never was put in.

5431. *Chairman.*] When you were there, did you see it?—I did not.

5432. Would that coffer-dam have cost about 16,000 *l.*?—I think that that was our estimate for it.

5433. Then, in fact, the contractor was saved the amount of 16,000 *l.* if it was not put in?—He was bound to put it in if the engineer ordered it or if it was necessary, but in the event of his not putting it in he would save 16,000 *l.* I believe it has not been put in; I have been on the

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the ground and have looked it over, and at any rate, if it has been put in, it has been taken out again.

5434. If it had been put in would it have been there now, as the work has not been completed?—They might have drawn it out again; but I was told that it was not done.

5435. Must not every man who tendered for the work at that place have increased his tender by somewhere about the amount of 16,000 *l.*, under the belief that he would have to make this coffer-dam?—I do not know what Mr. Furness did; I did it, and I think several other contractors did it.

5436. Do you suppose that every other contractor would have increased his tender by the amount of 16,000 *l.* under the supposition that he would have to make a coffer-dam?—I do not know to what amount they would have increased their tenders; but they would certainly make some allowance for putting it in.

5437. Has this sum been deducted from what has been paid to Mr. Furness for that contract?—I cannot tell; I only know that Mr. Furness's was accepted for 164,000 *l.*, and I think it included 10,000 *l.* for extra works, including the coffer-dam, and everything, as I understood, at the time.

5438. Were any extra works performed?—I cannot tell.

5439. If it had been known beforehand by the specifications that no coffer-dam would be required, of course the tenders would all have been lower by that amount, would they not?—Mine would, and I presume that the rest of the contractors would calculate accordingly.

5440. (To Mr. *M'Cormick*).] You were associated with Mr. Ridley, were you not, in the tender that you put in for the first portion of the Low Level Sewer, which is to be covered by the embankment?—Not at the time that I made the tender first. Mr. Ridley came to me afterwards; I happened to be in Ireland, and he sent to me. The estimate for the coffer-dam was double what it ought to have been, and I remonstrated with my man, and told him that it was wrong. I had been building a good many coffer-dams just previous to that, some very large ones at Birkenhead, and I told him that he must be wrong in the quantities; he said, no. I decided that night, before I went to bed, to tender on my own sketch, which sketch I gave to the Chairman of the Board of Works afterwards. The next morning my man said to me, "Now, I did not like to contradict you last night further, but depend upon it they will all tender upon this plan," (producing this plan which I have in my hand), and he persuaded me to tender on that which was wrong; that was my own man who was getting out the quantities; consequently the estimate was too high; then Mr. Ridley came to me afterwards, and I compared the quantities with him, and, with the exception of the coffer-dam, I found that we were within about 4,000 *l.* of each other; and then I agreed to join Mr. Ridley.

5441. Did you write to the Chairman of the Metropolitan Board of Works to state that you would join Mr. Ridley in that contract?—I did.

5442. Have you carried out works of as great magnitude as that?—Much greater, and much more difficult.

5443. Would you state some of the works that you have carried out?—The Liverpool and Birkenhead Docks together for 20 years. We had a coffer-dam there which was 50 feet high, taken down at about the same time, with 80,000 feet of timber in it; that was an immense thing, and far more difficult to do than the whole thing together is here, for the rise of the tide was nearly 30 feet against us; and I have carried out many other works, of course.

5444. (To Mr. *Ridley.*) With regard to the Low Level Sewer covered by the embankment, did you buy a copy of the specification?—I did; I paid 20 *l.* for the specifications.

5445. Will you read what is stated at page 38, clause 60?—"It is hereby agreed that the contractor shall apply to the Thames Conservators on behalf of the said Board for such gravel and other materials as may be approved by the engineer of the said Board, for filling in behind the said embankment wall at such times as the Board shall sanction; and the payment of such sums as the Board shall have to make for the same shall be part of the contractor's liability, and shall be deducted from time to time out of the instalments due to the contractor."

5446. How many cubic yards of material did you calculate would be required to fill in that portion behind the embankment?—598,775 cubic yards.

5447. Intending contractors were given clearly to understand by the specification which you have read that the filling in was to be made of Thames gravel; was not that the case?—Certainly, and I made my calculation accordingly.

5448. It was imperative on every one to calculate what that gravel would cost, and allow for it in his tender?—The mud was to be cleared off the surface, and the whole of the inside was to be filled in with Thames gravel.

5449. Everyone who put in a tender would be obliged to ascertain what he would have to pay for that Thames gravel, and allow for it in his tenders, would he not?—He would.

5450. Did you go to the office of the Thames Conservancy to ascertain the price of the gravel?—I sent Mr. Cleaver.

5451. (To Mr. *Cleaver.*) What did they tell you at the Thames Conservancy Office was the price of that gravel?—6 *d.* a-ton put on board the barges, but the contractor must find his own barges.

5452. How much would that be a cubic yard?—About 6 *d.* a cubic yard is rather more than a ton.

5453. For 598,775 cubic yards, which Mr. Ridley has stated it would require, what would you have to pay?—About 15,000 *l.*

5454. To this would you not have to add the expense of hiring barges, and of loading and unloading those barges, and then spreading the gravel?—Yes.

5455. What would be the lowest estimate for that, per yard?—I estimated it at 59,877 *l.* altogether.

5456. Mr. Ridley has just stated that, before laying the gravel, you would have to remove the mud; at what would you estimate that work?—1,000 *l.*

5457. Then, if I understand you rightly, these three sums together amount to about 85,000 *l.*?—No; the 15,000 *l.* is included in the 59,877 *l.*

5458. Then it is about 69,000 *l.*, is it not?—Rather more than 69,000 *l.*

5459. But if those who intended to contract had known beforehand that they need not allow for Thames gravel in their tenders, would not all the tenders have been lower, by the amount of 69,000 *l.*?

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69,000 *l.*?—More than that, for this reason, that they would be paid for the privilege of shooting the rubbish.

5460. But, as far as we have gone, you would say that every tender would have been 69,000 *l.* less if they had known that they need not put the Thames gravel in?—Yes, at the very least.

5461. Would that have been the best material to put in?—Yes; decidedly.

5462. In the specifications was it stated that a contractor would be allowed to make arrangements with other parties, to get paid by them for the liberty of shooting rubbish?—No.

5463. If so, you could have put in a lower tender still, even after subtracting the 69,000 *l.*?—I could.

5464. What would have been about the total sum by which you could thus have reduced your tender had the Board stated that you might have received payment for the liberty of shooting rubbish, and be exonerated from using gravel?—I should think about 80,000 *l.*

5465. Then every tender would have been about 80,000 *l.* less than it really was, if those circumstances had been really known?—I should think so.

5466. Would that rubbish, which is now being put in, be as good as Thames gravel?—Certainly not.

5467. With what is Mr. Furness filling in at present?—With rubbish brought from different parts of London.

5468. Does that rubbish consist of bricks, mortar, clay, and all sorts of things?—Yes; there is a great quantity being brought from the Underground Railway.

5469. Then Mr. Furness saves all the price of this gravel, does he not?—He does.

5470. And he receives payment from those who shoot rubbish in?—He does.

5471. Have you any notion of the amount of payment which he is receiving from those persons?—I have ascertained that he has an arrangement with a Mr. Jay to receive 6 *d.* a-load for the privilege of shooting rubbish there from the underground railway, but the usual price they charge is 9 *d.*

5472. How many loads a-day do they get?—I cannot say.

5473. Then, in fact, it is not the ratepayers, but Mr. Furness who pockets this 80,000 *l.*; is that so?—Quite so.

5474. Was it stated in the specifications that this filling was not to take place until after a coffer-dam had been completed?—No, it was not stated so, but I took it for granted that it would not be allowed to be filled up until after the coffer-dam was formed.

5475. Why did you take that view?—On account of the tide washing it down.

5476. You think that the river and the tide would wash away the stuff that was put in?—Yes, in a great measure.

5477. And would it tend to fill up the bed of the river?—Yes.

5478. Was the coffer-dam to be made of iron caissons, without extra charge; that is mentioned in clause 11 of the specifications, is it?—It mentions in the specifications that it is to be done either with iron caissons or in any other way as the engineer may direct, without any extra charge.

5479. Is there a coffer-dam there, either of iron caissons, or of anything else?—There is a coffer-dam now being formed of iron caissons.

5480. Did you not state that they had already begun to shoot the rubbish in?—They have been doing so for some time.

5481. Before they made the coffer-dam?—Yes.

5482. Does the river wash down any part of this rubbish?—Yes, a great quantity of it; it must of necessity do that.

5483. Do you know that from your own knowledge?—I do; I have watched it continually ever since; I have been up and down in the steamboats, and I could see the rubbish washed away, the rubbish being of soft material.

5484. Could you see it discolouring the water as it was washed away?—The mud is very thick, and the banks are much worse than they were.

5485. Does it tend to choke the stream?—Yes.

5486. Do those carts bringing this rubbish backwards and forwards tend also to choke the streets?—They must do so very much; there are seven or eight in a line one after the other coming along Fleet-street constantly.

5487. So that besides the ratepayers being mulcted of upwards of 80,000 *l.*, are they put to great inconvenience by all those carts?—They are.

5488. To whom do those carts belong?—To different contractors; most of them are hired by different contractors.

5489. (To Mr. *Ridley.*) How many loads were put in yesterday?—Seven hundred and forty loads, I believe, were put in yesterday.

5490. Who is it that states that?—There was a man put on to count.

5491. Did you put on a man to count?—Yes.

5492. Mr. Furness is paid 6 *d.* a load for that, is he not?—I do not know the price that he is paid.

5493. (To Mr. *Cleaver.*) Can you state what Mr. Furness is paid for that?—It is 9 *d.* a load usually; but he has a contract with a Mr. Jay, and on account of the immense quantity of rubbish, he has to receive it all for 6 *d.* a load.

5494. From others does he receive 9 *d.* a load?—Yes.

5495. (To Mr. *Ridley.*) Do you know any cases where contractors for any portions of the main sewers have been allowed to make alterations or deviations from the prescribed line, in order to save expense?—The line is changed in some places.

5496. Is it changed from what was originally prescribed in the specifications?—Yes.

5497. If that change has been a saving of expense then, have the ratepayers gained by that or the contractor?—I presume that the contractor would gain. The Low Level Sewer is changed from the prescribed line in the Old Kent-road, near the Surrey Canal, and also in Kennington Oval, and in another place or two; instead of cutting through Kennington Oval they are allowed to go along the road, instead of going through expensive property; and they were allowed to do the same in the Old Kent-road.

5498. Would that be a saving of expense?—It would save the compensation.

5499. Was that deducted from the payments made to the contractor?—I am not aware; I have not seen the arrangement. At the Nine Elms station you are supposed to continue on the road, and Mr. Brassey's engineer told me that he put down 10,000 *l.* for getting through there.

5500. If

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5500. If the works were laid out in the best manner at first, those deviations would make the works worse, would they not?—I could not say that, because when works are first started you are not aware what alterations may be necessary.

5501. But if those deviations had been contained in the original specifications, the estimates would have been lower for that portion of the works?—In Kennington Oval and in the Old Kent-road they would.

5502. Do you know any case where the Board has raised the contractor's prices after the contract has been secured to him?—I do not know for a certainty, but I have heard that that has been the case.

5503. In the specifications for the first section of the embankment, at page 38, I find that the contractor is directed "to provide and include in his tender the sum of 50,000 *l.*, for meeting the expenses of extra works beyond those included in this specification"; is it usual to make any allowance for works not named?—As a general rule, the engineer says in his specification that any additions to or deductions from shall be taken from the schedule of prices; but I have not found it to be in a lump sum in this way. You will find that, at the end of the specifications, there is a schedule of prices, to be filled up in the event of any extra work being done.

5504. For instance, at page 37, clause 59, if those 5,000 cubic yards of excavation which are there mentioned be found necessary, is that to be taken at the prices mentioned in the schedule at the end?—I understand it so.

5505. And the 15,000 cubic yards also?—Yes.

5506. And the 500 rods of brickwork and the Portland cement?—Yes.

5507. At the end of the clause, after enumerating all those extra works, you will find that the contractor is "also to provide, and include in his tender, the sum of 50,000 *l.*, for meeting the expenses of extra works beyond those included in the specification"; is that usual?—I do not reremember to have seen it in any specification.

5508. (To Mr. *M'Cormick.*) You have been contractor for very large works; what is your opinion of that clause?—I quite understand it; I have known it to be done at Birkenhead, by Mr. Rendell, expecting that there would be some extra works to be done. They might or they might not be done, and they would be paid for by the schedule of prices.

5509. Besides the provisional quantities, do they also allow a sum for extra works?—There has sometimes been a sum put down expecting that there would be some extra works; but if those works were not executed by the contractor he did not get paid for them.

5510. It is not a common thing, is it?—Not at all.

5511. Would you expect that if they were put down, they would be deducted afterwards from the price to be paid to the contractor?—Just so; if he executed them he would be paid for them; but if he did not execute them they would be deducted from the total.

5512. (To Mr. *Ridley.*) Was not 10,000 *l.* ordered to be provided for works at the reservoir on the north side?—That was the amount for extra works.

5513. (To Mr. *M'Cormick.*) After the contract for the first section of the Low Level Sewer, which is covered by the embankment, was given to Mr. Furness, was not there a bill filed in Chancery against Mr. Bazalgette and Mr. Furness?—I have heard so.

5514. What was that for?—About some contract in Odessa; but I have no thorough knowledge of it myself; I heard it from my solicitor.

5515. (To Mr. *Ridley.*) Are you acquainted with the circumstances of that contract?—I am not.

5516. Was not that question of the Odessa contract referred to a Committee of the Metropolitan Board?—I heard so.

5517. Have you seen the Report?—I have read it in the newspapers.

5518. Did they refer to your tender?—Yes, I think they did.

5519. Did they state why the contract was not given to you?—I do not remember the precise words of it; I know there was a Committee upon it.

5520.—It appears, by the Monthly Reports which have been laid before this Committee, that at the end of May Mr. Furness was paid 33,000 *l.* on his contract; do you know the amount of work that had been done up to that period?—I do not; I was surprised when I saw it, as my price for the coffer dam for the whole length was about 9,000 *l.*; the way I looked at it was that he should have had nearly one-third of the coffer dam in, besides some of the earthworks; he had very little of the coffer dam down at the time; I do not think there was any down; I was told there was not.

5521. (To Mr. *Cleaver.*) What was the value of the work done; did you look at it?—I did as well as I could.

5522. Did you estimate how much work was done up to the end of May?—As soon as I saw that report in the papers I did.

5523. How much work had been done?—I should think, strictly speaking, according to the contract, there was not more than 10,000 *l.* worth of work done.

5524. Was that at the time he was paid 33,000 *l.* —Yes.

5525. Could not he charge for the timber-staging?—No; that is plant, in order to enable him to do the work.

5526. Mr. *Tite.*] Did you measure this, or is it only a general guess?—It is a general guess.

5527. With regard to the filling in, of which you have spoken, you state that it requires 598,775 cubic yards?—It does.

5528. That, of course, is the whole filling in from bridge to bridge; that is the whole quantity of backing?—That is the whole quantity, after deducting the excavations from the river-wall.

5529. Which are to be thrown back?—Yes.

5530. Therefore, the whole quantity has been estimated by you at the price you speak of?—The actual quantity to be filled in.

5531. Have you any idea as to how much rubbish has been put into the backing, of which you speak, at the present moment, because this is a total quantity when the whole work is completed; that is so, is it not?—Yes.

5532. Therefore, if the filling in of the rubbish were stopped at the present moment, what quantity of rubbish (which you think an improper material) has been put in there?—I should think from 150,000 to 200,000 loads.

5533. Is it as much as that, if the whole quantity to be put in is only 600,000 loads?—I should think so. Is the Honourable Member alluding to the first contract only?

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5534. My question referred to the first contract?—There would be about 100,000 loads.

5535. With regard to the nature of the material, which has been put in, you state that Mr. Jay supplies it from the Underground Railway; is that so?—A great quantity of it.

5536. Is not that gravel?—No.

5537. What is it?—It is mould, and the rubbish that is dug out there is not gravel at all.

5538. Where is it dug from?—At Farringdon-street, where they are making the extension of the Metropolitan Railway.

5539. You say that that is mould or earth, and not solid material?—Yes.

5540. Do you know that of your own knowledge?—I do; I watched the carts yesterday myself.

5541. Where does Mr. Lucas's rubbish come from?—I do not know; there are several contractors that are carrying rubbish of all descriptions.

5542. That rubbish is from excavations from various works that are going on in London, and instead of being tipped in another place it is tipped in this place, be it what it may; is that so?—Yes, it is.

5543. With regard to the carts, of course where there is an excavation going on, there must be carts to carry away the rubbish; is there any more of that in this instance than in any other instance?—It blocks up Fleet-street very much.

5544. Supposing that this rubbish were to go as probably it would go, towards the outer portion of the town to fill up the low level lands at Battersea, for instance, would not the same consequence follow?—They would not go in the same tract as they do now.

5545. Why not; if they were going from the works in Farringdon-street?—It is all concentrated into a crowded locality.

5546. How could you avoid it if you were going westward?—The carts go from various points.

5547. If they are going from one point to another point, the carts must go in a line, must they not?—Yes; but you concentrate them all to one focus where it is very much crowded; whereas the excavations are going on in different parts of London.

5548. (To Mr. *Ridley.*) Did you tender for the Southern Low Level Sewer at 215,000 *l.*?—I did.

5549. And you afterwards declined to carry out that contract, did you not?—Yes; in that contract there was a clause for easement, and my surveyor made up the amount from Deptford to Putney at 5,000 *l.*, and then he went to 10,000 *l.* I went into the earthworks and brickwork, and all the contractor's part, and I left the rest to him to give me what he considered was right. After the tenders were opened, I asked him more in detail about this compensation question, and he could give me no answer. I went to two solicitors, and I have ascertained that the question of easement not only means a right of way by the sewers for ever, but it includes the severance of property, which was such a speculative matter that I could get no value for it. I found further that some people had put down 70,000 *l.* or 80,000 *l.* for it, and my estimate was only 10,000 *l.*, and I wrote to the Board of Works to say that, in consequence of that word "easement," I declined to go on with the work.

5550. It was stated in evidence on the last meeting of the Committee, that one of the contractors had failed altogether, and was ruined by his contract; do you know that fact?—I do not.

5551. Do you know the success, or otherwise, of any of the contractors that have been taken by the Board; have their contracts turned out profitably, or otherwise?—I do not know, beyond mere rumour; a contractor can never tell what he has made until his debts are paid and his accounts are closed.

5552. Have any of the contractors failed, and have you called upon the sureties to perform the works, or have the Board undertaken them themselves?—I do not know that I have heard that.

5553. With regard to the amounts of the contracts; you attended at the Board on the day that the tenders were opened; yours was the lowest, and you were told that, subject to certain enquiries, you would have the work; was that so?—I was called into the room, and asked a great number of questions by the members of the Board, and the thing was left open to enquire into my sureties. I did not know what the enquiries were; I suppose it meant as to the sureties.

5554. Subsequently the Board did not see fit to accept your tender?—It appears not; they did not give me the contract.

5555. With regard to the coffer-dam, was there any explanation between you and the chairman of the Board on that question?—I never spoke to the chairman. I called upon the engineer one day, and I showed him the same class of coffer-dam that they are putting in now; I believe it is almost the same sketch; it was long timber, driven down as far as you can drive them, and well braced, and filled with clay, in the ordinary way, such as has been most successful for the last 20 years; I do not know of any other kind.

5556. *Chairman.*] (To Mr. *MCormick.*) With regard to your tender being 100,000 *l.* more than other people's, was that for putting a close coffer-dam both inside and outside of the wall?—It was on the coffer-dam alone.

5557. Did you think that plan necessary?—Certainly not.

5558. Do you mean that your estimate being so high was entirely owing to the mistake made by your man?—Yes; my man persuaded me that they would all tender upon that sketch.

5559. Who gave you that sketch?—It was sent over with the other quantities to Ireland.

5560. But where did it come from; had it any sanction from the office itself?—No; we considered that it was authentic.

5561. Do you mean that there were certain parties employed by the contractors to take the quantities?—Yes, there were two or three.

5562. Were they employed by the contractor, and not by the Board?—No; they wrote to the different contractors, Messrs. Gotto and Beasley.

5563. Did they send you that diagram?—Yes; I went to the chairman, and the same question was put to me, and the engineer, Mr. Bazalgette, produced the same sketch in the chairman's room; and then the chairman asked me whether I would still be inclined to join Mr. Ridley if he was to call upon me to perform these works. I said no, but that if he would make a sketch of what he thought was sufficient, I would give him an answer in one hour.

5564. What followed?—Nothing more.

5565. With regard to those provisions, you have stated, that it is not unusual to have a provision in quantity, and a provision in money for

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works of a difficult nature; that is a matter of arrangement subsequently, if the quantities are used; you are paid for them by the scheduled price, and if further works are required, they are measured, and also added; is that so?—Yes.

5566. And those matters are adjusted between you, the measurer, and the Board, at the end?—Yes, clearly.

5567. Mr. *Ferrand.*] (To Mr. *Ridley*). How much higher or lower was Mr. Furness's tender than yours?—I think that it was 25,000*l.* higher.

5568. Then, do you believe that Mr. Furness is to be paid that amount, although the coffer-dam should not be made?—They are bound to pay him the amount, because it is a lump sum up to a certain point, and then there are so many thousand pounds extra works after.

5569. Whether he puts down the coffer-dam or no, he will be paid that sum of money, in your opinion?—No; he is bound to make the coffer-dam to keep the water out, but his tender was 25,000*l.* higher than mine.

5570. But I understood you to say, that he contracted to put a coffer-dam down, and that that coffer-dam was not in existence?—They are at work at it.

5571. I am referring to the Northern Reservoir coffer-dam, and not to the Thames Embankment coffer-dam; did Mr. Furness contract to make that coffer-dam?—He did, subject to whether the engineer ordered it or not.

5572. Then if the engineer does not order it, it will not be made?—It is not necessary to make it; but if the engineer considered it necessary to be made, he would have to put it in at the price.

5573. If the engineer does not order it to be made, will there be any deduction from Mr. Furness's tender?—I think not.

5574. You have been asked several questions with regard to the alteration of the line of the sewers, and you state that several deviations have been made; have those deviations been made within the boundary set forth by the Act of Parliament?—I was not aware that there was any boundary in the specifications by the Act of Parliament.

5575. In the Act of Parliament under which these works are carried out, is not a certain deviation allowed?—In a railway there is a certain deviation, but I am not aware that there is for the sewers.

5576. If no deviation was allowed by the Act of Parliament, strictly speaking, is not the alteration of the line a trespass on property, unless some arrangement has been made with the owner?—I could not answer the question, because I do not know what the Act of Parliament provides for. In the case of a railway there is a certain limit of deviation, but I am not aware that there is any limit in the case of the sewers.

5577. Have you ever failed in carrying out any of your contracts?—No.

5578. No charge has ever been made publicly against you as a contractor, in having been a defaulter as to carrying out your works?—No.

5579. Then do you consider, as a contractor, that you have been ill-used, in your tender not having been accepted, and in a tender being accepted which is so much more than your own?—Very much so.

5580. Have any of you gentlemen examined this reservoir, which is 9 ½ acres in size?—I have not examined it. I was past it the other day, but I did not take particular notice of it; I saw that the works were still in progress.

5581. Have you heard it stated, or do you know of your own knowledge, that that reservoir is not of the size that was set forth in the estimates by the Board of Works?—I do not know; I did not measure it, and I have no idea. I have heard it said that it was not of the proper size, but I have no personal knowledge on the subject.

5582. (To Mr. *M'Cormick.*) Are you aware whether that is the case?—No.

5583. (To Mr. *Cleaver.*) Have you any knowledge on the subject?—No.

5584. Mr. *Hibbert.*] (To Mr. *Ridley*). How long ago is it since you last saw the reservoir on the north side?—A few days back; I believe it was on last Monday morning.

5585. At that time the works were still going on, and it was not completed, was it?—I did not pay much attention to the brickwork, and such as that; they were covering it all over; I think there were a good many men at work.

5586. What kind of work was going on?—The brickwork was unfinished, and the covering over the reservoir.

5587. Do you mean that the brickwork is arched over?—The brickwork is apparently most of it arched over.

5588. Then, is all that it requires, covering over with earth?—I cannot say how much has to be done, but it is not finished yet.

5589. Would you call it practically finished, to use the words of Mr. Bazalgette; could it be used?—I presume that it could; I think that they are using some portion of it, but not the whole.

5590. This coffer-dam that you have spoken of as not being made at all, was provided for in the specification; have you the terms of that?—I remember what was said about it; it was, that should an engineer consider it necessary to put down a coffer-dam, it was to be done by the contractor without any extra cost.

5591. Was there any arrangement in case the coffer-dam is not made, there should be a deduction made from the amount of the tender?—No; what it says is this, "For the protection of the river bank, or raised wall, the contractor shall, at his own cost, upon the engineer's order, either before the commencement or during the progress of the works, construct along the reed shore, to the engineer's satisfaction, a good and substantial piled and clay coffer-dam, to extend 50 feet at each end beyond the excavation for the reservoir, both next the River Thames and Barking Creek; and the contractor will be held wholly and entirely responsible for the proper maintaining and keeping up and in repair such river-wall, to the satisfaction of the Conservators of the river and Commissioners of Sewers of the marsh level, during the execution of, and for twelve months after the completion of the works." That was what I referred to.

5592. Then, do you suppose from that, that the contractor must have made that coffer, if he had been required to do so by the engineer?—Yes.

5593. And that no deduction would be made from the amount of the tender, if the coffer-dam was not made?—No; because everything was allowed in a lump sum; he would get paid if he did it, and he would get paid if he did not do it.

5594. With respect to the gravel to be used from

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from the Thames, it appears that the clause in the specification is, that for the purpose of providing gravel, sand, soil, and other materials, the Conservators of the River Thames may, when required by the Board of Works, raise those materials from the river; do you know whether the Board of Works have required the Conservators to raise the gravel from the river?—I do not know, as I did not get the contract; I only inquired where the gravel could be got, and I believe it was 6*d.* a ton for any amount.

5595. You are not aware whether the Board of Works have required the Conservators to find a sufficient quantity of those materials?—No.

5596. Can you state what quantity of gravel has been used from the River Thames?—I cannot: I do not know.

5597. Do you know whether the contractors have applied to the Board of Works or to the Conservators for gravel?—I do not know.

5598. Do you know when the contractors commenced tipping in this rubbish?—I do not know exactly the date, but it has been done for a length of time.

5599. Do you know when they commenced putting the rubbish in, before gravel was put in from the Thames?—I do not know whether they have put any gravel in or not; I saw some chalk put in the other day.

5600. Do you know whether any of the other contractors are allowing rubbish to be tipped in in the same way?—I believe that the second contractor is doing the same thing.

5601. Is that the one past the Temple?—Yes.

5602. Does he also receive payment for the rubbish?—I do not know what he receives; I cannot answer that question.

5603. Mr. *Ferrand.*] Does the contractor pay for the damage in passing through private property in the construction of those works?—In the sewers he has to pay for the severance of property and for the right of way.

5604. Mr. *Tite.*] But he does not purchase the property?—No; but if you take so much out of a person's garden you have to pay so much for it.

5605. Sir *Joseph Paxton.*] The contractor does not have to pay for the fee simple of the land, does he?—No.

5606. Mr. *Ferrand.*] In passing through private property you pay for all damages in laying out your works, do you not?—Yes.

5607. If Mr. Furness deviated on to a high road, instead of passing through a valuable property, would not that decrease his expenses considerably?—It would be the same with any contractor; if you could get on a public road, where there would be no compensation to pay for gardens, and fields, and so forth, that would be, of course, very much better; and it makes it so much the better for carting your material away, and everything of that sort.

5608. Is there any clause in the contract empowering you, or was there any statement made by the Board before you put in your tender, that you would be allowed to deviate in carrying out the works?—I think not, but I am not certain about it.

5609. When you put in your tender, was it under the opinion that you would have to go exactly on the lines laid down on the map?—Yes, and I calculated upon it.

5610. Mr. *Tite.*] Is Mr. Furness, the contractor, there?—No.

5611. Did he do the works?—No, Mr. Webster did.

5612. *Chairman.*] Is that the person that has the contract on the south side?—No, there is no Mr. Webster, that I am aware of, that has got the contract on the south side. Mr. Ritson has got one contract. Mr. Webster got a contract, a few days ago, on the north side.

Mr. CHARLES MILLS ROCHE called in; and Examined.

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5613. *Chairman.*] ARE you a member of the Metropolitan Board of Works?—I am. I think it right to say that I attend here under an order which I have received, having had no information whatever upon what points the Committee wish me to give evidence.

5614. Can you state whether the lowest tenders are usually accepted by the Metropolitan Board of Works?—Yes; we usually accept the lowest tenders, unless there is some good reason to the contrary.

5615. Can you inform the Committee why Mr. Ridley's tender was not accepted?—Will you allow me to ask this question: should I be justified in stating to this Committee that which passes in a committee of the Metropolitan Board of Works?

5616. Certainly; why not?—We consider those communications, to a certain extent, confidential among ourselves; if the Committee tell me that I am bound to answer, I suppose I must answer.

5617. You are bound to answer the question: can you state why Mr. Ridley's tender was not accepted?—Yes, I can tell you.

5618. Mr. *Tite.*] Were you on the Committee?—Yes, I was on the Committee. I only wish to do that which is honourable towards the body to which I belong; I do not wish to give evidence as to what transpires in that Committee unless this Committee think that I ought to do so.

5619. Why was not Mr. Ridley's tender accepted?—If I am bound to state to this Committee any confidential report that was given by the engineering committee of our Board, I believe it was in consequence of a report from the engineer, Mr. Bazalgette, who reported that Mr. Ridley was not competent to carry out the contract.

5620. Did he mean that he had not engineering capabilities?—I cannot now state the terms of the report. There was a report from Mr. Bazalgette to the Committee, and that report stated in effect that he could not be responsible if Mr. Ridley's contract was accepted, although we had already accepted it.

5621. Did Mr. Bazalgette state why he would not be responsible?—I cannot carry the terms of the report in my mind, but it was evident to me, at all events, and to others, that that was Mr. Bazalgette's opinion of Mr. Ridley.

5622. Was it evident to you that (according to your officer's account) Mr. Ridley was incompetent, as a contractor, or that he had not sufficient funds to give in security?—My own opinion was, that Mr. Ridley was competent to carry out the contract. I was satisfied in my own mind that he was, in spite of what Mr. Bazalgette stated; that

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that was the opinion that I came to after most careful inquiries as to his capability and his responsibility.

5623. Mr. Ridley has stated to the Committee that the total amount of his security was 20,000 *l.*; are you aware that that was the case?—That was so.

5624. Are you aware that he stated that his solicitors wrote to the chairman of the Board of Works, saying that they would deposit the whole amount of his security, namely, 20,000 *l.*?—I believe that was so.

5625. So that there was no doubt about his security?—I believe that that was so.

5626. Are you aware that Mr. M'Cormick offered to join Mr. Ridley in his tender?—Yes; it was so stated.

5627. Mr. M'Cormick is a man of great engineering capabilities, is he not?—Yes.

5628. Was it stated in the report that Mr. M'Cormick was prepared to join Mr. Ridley?—I think not; it was decided in the Committee that no reference should be made to Mr. M'Cormick in the matter.

5629. Did it not appear very important that a man of Mr. M'Cormick's eminence as contractor was willing to join in the tender?—It was so; but there were other considerations which pressed upon the minds of the members of that Board, which affected Mr. M'Cormick personally, and therefore it was thought better not to introduce his name.

5630. There was a statement made at that time that Mr. Bazalgette was to receive 12,000 *l.* as a commission from Mr. Furness; do you remember those circumstances with regard to the Odessa contract?—Yes.

5631. That affair was referred to a committee of the Metropolitan Board of Works, was it not?—It was.

5632. Was not that committee appointed to consider Mr. Bazalgette's conduct with regard to the Odessa affair?—It was.

5633. They reported on the 25th of November 1862, did they not?—No doubt.

5634. Was Mr. Bazalgette exculpated by that Report?—I think not: I think the Report condemned him, if I recollect rightly. It said: "The committee disapprove of their engineer having been concerned in any transaction with any contractor without the consent of the Board, and in contravention of the terms of his appointment, although in respect of works to be performed in a foreign country." The Board did disapprove of his conduct on that occasion.

5635. Was this business before Mr. Ridley's tender for the Low Level Sewer and embankment was refused?—Does the noble Lord refer to the report of the Committee, and the investigation, or to the previous arrangement between Mr. Bazalgette and Mr. Furness?

5636. Did the previous arrangement take place before Mr. Ridley's tender was refused?—Yes; I should say sometime before; the Bill in Chancery and the answer would give all the dates.

5637. Was the contract for the first section of the embankment given to Mr. Furness before or after that report?—Before this report.

5638. Mr. Furness got the contract before this matter was reported upon?—Certainly; there is no doubt of it. I think that he would never have had it if it had been known before.

5639. Did you not state that the contract was refused to Mr. Ridley because of Mr. Bazalgette's report concerning Mr. Ridley?—I will not say that it was entirely because of that; Mr. Bazalgette did, in a confidential report, as I considered it, state that he considered that Mr. Ridley was incompetent to carry out the contract.

5640. Mr. *Tite.*] Was that in writing to the Committee?—I think so. Then, Mr. Ridley's capabilities and his pecuniary position were gone into by the Board in a very stringent way indeed; and the Board came to the conclusion not to give him that contract.

5641. *Chairman.*] In spite of his solicitor having offered to deposit the whole amount of security?—Yes; I do not remember now how I voted, though I felt that it would be imprudent in our Board to give a contract to a person in whom the engineer had not any confidence.

5642. Was the time when Mr. Bazalgette stated that he had not any confidence in Mr. Ridley after the Odessa contract and the engagement had been entered into, and before it had been investigated by the Metropolitan Board?—Yes.

5642.* That matter of the Odessa contract had been kept secret, had it not?—The Board knew nothing about it, or, at least, I knew nothing about it, and I believe that the other members were much in the same position.

5643. The ratepayers had to pay 25,000 *l.* more than if the contract had been given to Mr. Ridley, had they not?—That is so.

5644. That Odessa affair is still pending in Chancery, is it not?—I believe so.

5645. Do you personally think that this affair of the Odessa contract had anything to do with Mr. Bazalgette's taking an energetic part in securing the contracting to Mr. Furness, or would you rather not answer that question?—I had rather not answer that question, because those are questions of motives, and I do not like to attribute motives to other people.

5646. Do you think that the investigation on that occasion into the Odessa business, was a genuine investigation, or was it rather of the nature of a farce?—No; I think that the investigation was perfectly genuine on the part of the Board.

5647. Did you consider that Mr. Furness was a man of great experience in engineering works?—No, I never entertained that opinion; but the engineer, in reply to a question which I put to him at the time, stated that he considered him perfectly capable of carrying out the contract.

5648. Would you be surprised if you heard that Mr. Furness had never carried out any works of the kind?—No; I should not be surprised.

5649. Would you be surprised if you heard that Mr. Ridley had carried out works of that nature, and that Mr. M'Cormick had carried out works of still greater magnitude?—Mr. Ridley so stated to the Board at the time, but that was subsequently doubted.

5650. The report stated, that Mr. Ridley had never carried out such works before, did it not?—Very likely; it was stated that he had not carried out the works, but he asserted that he had, I believe.

5651. It states, that although he had executed works in America, yet that neither his operations in that country nor in this country, were comparable to such an undertaking as the Embankment?—Yes; that is what the report states.

5652. Then, if Mr. Ridley had carried out such works, and if, on the contrary, Mr. Furness had not,

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not, this report is entirely delusive, is it not?—I would rather say that it was in error; I believe the report to be perfectly *bonâ fide.*

5653. Did you sign this report?—No, I declined to sign the report for some reasons: I did not agree with some parts of it.

5654. Mr. *Tite.*] The Board of Works have had an opportunity of judging of the experience of Mr. Furness in carrying out works to a very great extent in the Main Drainage Lower District, and the two Houses of Parliament, and they have had an opportunity of seeing the character and style of those works; was there not great satisfaction expressed that the work was very beautifully performed, and carried through with great spirit?—I think that the engineer always reported that the work was very satisfactorily performed.

5655. I have some recollection that Mr. Bazalgette had not given such a positive report as to Mr. Ridley; are you quite sure as to that?—The fact is firm on my mind, because I know that I was guided in my ultimate opinion, and in the vote that I gave, entirely by the engineer's report, because I came to the conclusion that it would be utterly impossible to get those works carried out by a contractor who Mr. Bazalgette seemed to think could not possibly do it.

5656. It is in writing, is it not?—Yes, it is; but as the Honourable Member knows, at Committee meetings a great many things are said which are not put in writing, but which still affect the minds of members who have to vote upon the question.

5657. Mr. *Ferrand.*] Was not Mr. Ridley's tender accepted by the Board?—It was.

5658. And the Board were perfectly satisfied with Mr. Ridley, and with his tenders until they received a written report from Mr. Bazalgette recommending the Board not to accept Mr. Ridley as the contractor; was that so?—They accepted the tender subject to the usual enquiries, and at a subsequent Committee meeting Mr. Bazalgette then reported (I cannot carry the terms of the report in my mind, but it was to this effect) that he felt it his duty to report to the Board that he could not be responsible for those works being carried out if Mr. Ridley was the contractor; that was the spirit of his report.

5659. Did he set forth his reasons, or grounds for that report?—I do not remember that.

5660. Do you think that he did not?—I cannot speak as to that.

5661. It has been stated to the Committee in evidence to-day that Mr. Webster has deviated considerably from the line set forth in the plans and specifications for which he contracted; is that correct?—I cannot say; I have no doubt that it is so. When those applications are made to the Board they are either acceded to or not upon the report of the engineer.

5662. Is the Board aware that Mr. Furness in his contract is bound to use Thames sand, which is likely to cost about 6 *d.* a ton, in carrying out his works, and that instead of using that Thames sand he is receiving a certain sum of money per ton for rubble, and all kind of rubbish being shot into the place where the Thames sand ought to be used?—As a member of the Board, I was not aware of it until I heard it stated in this room this morning; but what the other members of the Board may know, of course I cannot state.

5663. May I ask you whether you were surprised to hear that statement?—I was rather surprised.

5664. Are you aware whether the coffer-dam which has been alluded to is to be paid for in the contract with Mr. Furness, if he does not make it?—No, I think not; I think that that does not refer to the Thames Embankment at all; a coffer-dam must be placed there of some description.

5665. Then, in your opinion, the coffer-dam would have to be made and placed there?—I apprehend that that must be so.

5666. Have you heard that the reservoir, which is 9¼ acres in extent, is not of the size contracted for?—I never heard of it until this morning.

5667. Mr. Bazalgette has never reported anything connected with that reservoir to the Board?—I cannot say that he has never reported it; I have no knowledge of it as a member of the Board, but he may have reported it when I have not been present.

5668. Mr. *Hibbert.*] Was it the committee or the Board which first accepted Mr. Ridley's tender?—The Board.

5669. Then, afterwards, was the report from Mr. Bazalgette made to the committee?—To a committee of the whole Board.

5670. Have you had any report at all from the engineer, as to the difficulty in obtaining sand from the Thames Conservators?—There may have been a report, but I am not aware of one. I do not attend the committees of the Board very regularly.

5671. You are not aware whether the engineer has made any report at all about the contractor using this material?—I have no knowledge at all about it; it may have been stated to the committee on that subject; but I have never heard any statement on that subject when I have been present.

5672. Mr. *Cowper.*] Upon the occasion when Mr. Ridley's tender was not accepted, I believe that the next lowest tender was that of Messrs. Baker & Son. I observe that in the report of the committee they state, that Messrs. Baker & Son were pre-eminently qualified for the work, and were one of the first firms in the country, but that they declined to enter into a contract without so serious an alteration of its conditions as would be impossible for the Board to accede to. Are you prepared to state what was the alteration of the conditions that Messrs. Baker & Son required? — They required an arbitration clause, for one thing; I do not know whether there was any other. I think that the arbitration clause was the great difficulty; they would not enter into the contract giving to the engineer that enormous arbitrary power which our contracts give.

5673. It has been the policy of the Metropolitan Board not to agree to that arbitration clause, has it not?—Yes, because we raised the question subsequently, and many of us consider, and I myself still consider, that the want of that arbitration clause compels us to pay much more for our contracts than we should otherwise do.

5674. So that the refusal of Messrs. Baker & Son's tender was, firstly, because the Board thought that it would have given an unfair advantage to them over other parties, if an alteration was made to meet their views, and, secondly, because the policy of the Board, as decided by the majority, was, that the arbitration clause should not be received?—That was so.

5675. Then it is stated that the engineer advised the Board to abandon all the other tenders, and to readvertise for fresh ones. Could you state why the advice of the engineer was not followed in that respect?—I believe that the cause was that the Board had found upon a previous occasion, when they had to readvertise, that they were considerable losers; that the engineer's price having become known, if they had readvertised, the tenders might have been very much higher; I believe that was the reason.

5676. May I ask whether that matter was much considered and discussed by the committee of which you are a member?—I do not think that it was discussed very much, still it was well considered, and the Board came to that conclusion *bonâ fide* no doubt.

5677. The apprehension, I understand, being that if a fresh call for tenders was made, all the tenders that were sent in might possibly be higher than the tender of Mr. Furness, which was under consideration to be accepted; was that the case?—Yes, the contractors then knowing the engineer's price, and what we considered it ought to be, and having a knowledge of all their own prices, would be in a position to combine and make their own terms.

5678. *Chairman.*] Are you aware that the arbitration clause is a very common clause to put in every contract?—It is put in by many of the Government Departments; I believe that the War Office insert it, and many other public bodies, and many contractors refuse to take a contract without it.

5679. Is that the reason why you state that the absence of the arbitration clause makes you, that is to say the ratepayers, pay very much more highly for their works?—I believe that the want of the arbitration clause limits the number of competitors and increases the price of the contract, because the contractor is completely in the power of the engineer in every respect; he has to judge and arbitrate on all his own acts, which I have always considered, as a professional man, and engaged in drawing many contracts, to be very unfair.

5680. Why is that which you have styled this enormous arbitrary power given to your engineer?—The majority of the Board determined to give it to him.

5681. That determination was not at all shaken after you found reason to find fault with him with regard to the Odessa business?—The majority thought not. I think differently.

5682. How was it that you never heard that the contract was not being properly carried out, and that instead of gravel being used to fill in behind the Embankment, this rubbish was being used?—As I say, I do not attend these committees very regularly. It may have all come up before the committee for what I know.

5683. In whose power is it to relax the conditions of a contract?—The engineer, I suppose.

5684. Has he that power, independently of the Board, or of a committee of the Board?—I do not know what power he has of relaxing conditions, but if they are relaxed they are relaxed under his authority and by his advice.

5685. In the specifications it appears that Thames gravel had to be bought from the Thames Conservators, and that those places were to be filled in with it; supposing that it were given in evidence (as it has been to-day), that instead of buying the gravel from the Thames Conservators, the contractor receives payment from other persons for permission to shoot rubbish in instead, would not that be a relaxation of the conditions of the contract?—I conceive from what I have heard here this morning, that it must be a very great benefit to the contractor.

5686. Have you heard it given in evidence by Mr. Cleaver, Mr. M'Cormick, and Mr. Ridley, that the contractor would pocket 80,000 *l.* by so doing?—I heard so.

5687. Do you not consider that such a great relaxation as putting 80,000 *l.* into Mr. Furness's pocket, should be brought before the Board, and considered by the Board?—If it is so, I imagine that it ought to be brought before the Board; I have some recollection of a letter having been written from the Thames Conservancy to the Board, complaining of the quality of what we were filling up with, and upon that there was some report from the engineer, but I never read that report, and I do not know what they did upon it.

5688. Did that letter complain of their putting in rubbish, and damaging the river?—I have some dim recollection of seeing it on the notice papers.

5689. Did the Board take that into consideration?—Yes, it was considered.

5690. Did it appear in the notice papers?—Yes.

5691. Were you there when it was discussed?—I do not recollect being present.

5692. They still continue to put the rubbish in instead of gravel?—Yes, I conclude so, from what I heard this morning.

5693. Mr. *Tite.*] With regard to the arbitration clause, do you know, or do you not know that the engineers, as a body with, I believe, no exception, refuse to allow the arbitration clause to be inserted?—No, I know nothing of the sort.

5694. Do you know that the architects, as a body, allow it to be inserted?—Having more to do with architects than with engineers, I know that architects consider it a right and proper clause to be inserted.

5695. Do you know that engineers usually refuse to have it inserted?—I know that the War Office insert it, and when the question was discussed at our Board, Mr. Miller brought forward, I think, the War Office contracts, in which they permitted an arbitration, to a certain extent, not as to the quality of materials, but as to the extras.

5696. What was it for?—The fortification contracts.

5697. It was a military engineer then, was it not?—I believe so.

5698. However, you do not know that the practice of the engineering body is universally, so far as I know, to refuse to insert that arbitration clause?—I would never allow a client to sign a contract without an arbitration clause.

5699. You have forgotton, no doubt, the circumstance that Mr. Bazalgette, in the report to which you have referred, distinctly recommended the Board to re-open the question, and to have a new competition on the matter?—I do not remember that in his report; it was stated in conversation to the committee that he intended to do so.

5700. But the Board, upon consideration, thought that unwise, did they not?—Yes.

5701. Do you recollect a case in which they adopted

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adopted that course?—Yes; it was in Rowe's contract, I think, which the sureties were not able to carry through. I think that we had to re-advertise that, and that was the only case that I recollect of re-advertising. That was a contract on the Middle Level Sewer, and we had to pay a very much larger sum of money than the first lowest tender; which was Rowe's.

5702. Lord *Fermoy.*] With regard to the leaving in or the leaving out of the arbitration clause, was that discussed generally at the Board?—Yes, there was a special motion upon it; Mr. Miller brought forward a special motion, and it was discussed at the Board.

5703. Was it discussed in open Court?—Yes.

5704. And was it decided?—It was decided against.

5705. Did I rightly understand you to state that the effect of leaving out that arbitration clause is to diminish the number of contractors applying?—Decidedly; Messrs. Baker & Son, for instance, will not compete unless they get an arbitration clause, and Messrs. Lawrence & Co., the great builders, will never go into a contract, I believe, unless they get an arbitration clause; and many others do the same.

5706. When you came to discuss the question of re-advertising for tenders, you had to deal, in the first place, with a number of contractors, which would be limited by reason of the absence of the arbitration clause, and you fancied that the result would be, that that limited number of contractors would be very apt to get together, and settle the question of the new tenders?—After they knew our price, we were, to a certain extent, in their hands.

5707. What is the custom in the Board as to the attendance of committees; does the chairman attend every committee?—Generally speaking, he does; but there is the vice-chairman of the committee, who takes his place if the chairman is absent; but he generally attends all the committees that he possibly can.

5708. You do not publish your division lists or attendances, do you?—They are all in the minutes.

5709. They are not published in the papers?—No.

5710. But, practically, the chairman and vice-chairmen are generally on every committee?—Yes; generally speaking.

5711. Your engineer-in-chief would attend when it was engineering business, would he not?—Yes, our engineer would attend when there was engineering business, and our architect would attend when there was architectural business, and our solicitor would attend when there was legal business.

5712. From your experience you do not agree to the proposition of the Honourable Member for Bath, that there is a fundamental objection on the part of engineers to that arbitration clause?—No; our own engineer stated at that time that he had no objection to a limited arbitration clause.

5713. Did he recommend it?—He stated that he had no objection to it, not as to the quality of materials, but as to extras.

5714. And notwithstanding that the majority of your Board decided against it?—They did.

5715. Can you state what their reasons were?—I think that some of the majority would be better able to answer that question than I am.

5716. Mr. *Ferrand.*] Do you know how many members of the Board were present when this arbitration clause was discussed?—A very fair number.

5717. How many should you say were present?—I cannot say now, but it was a full Board. The meetings of the Board are generally very largely attended, in comparison with their number.

5718. How many members are there?—Forty-five.

5719. Can you give any idea of the number of the minority on that occasion?—It was a large minority.

5720. Was it rather a close division?—It was not a very large difference; it was rather close, I think. I should think there was a majority of five or six; but it is impossible that I can recollect the exact number of those divisions; they are in the minutes.

5721. Mr. *Cowper.*] The Board took a course by which they had to pay 25,000 *l.* more than the lowest tender; is it your opinion that if, instead of doing that, they had called for fresh tenders, there would have been such a combination among the parties tendering that none of them would have tendered so low as Mr. Ridley did?—That is not my opinion; my opinion was rather that there were persons who would be glad to take it at something like the engineer's price, or something under, knowing what our price was.

5722. Was the engineer's price publicly known?—I think that it was upon that occasion; but we do not now state it publicly.

5723. Why should the fact of your rejecting the tenders of Mr. Ridley and Messrs. Baker & Son, and accepting that of Mr. Furness, have led you into a more economical course than by rejecting them all and calling for fresh tenders; could you explain that?—I cannot explain it, because my opinions were quite opposite.

5724. Then may I ask you, supposing that upon that occasion the Board had refused all the tenders that were then sent in, and had decided upon advertising afresh, and determined that in future they would accept the arbitration clause, was it clear to your mind that they would have been certain to get a tender less in amount than Mr. Furness's tender which they accepted?—They could not be certain of anything, but I should say that there would have been a very great probability of getting it at very much less, but at the time the general opinion was that we had better not advertise, and I think that I agreed with that at the time; there was a general concurrence in that view.

5725. Was the engineer's price on that occasion less or more than Mr. Furness's tender?—I cannot recollect, Mr. Bazalgette states that it was more.

5726. Mr. *Tite.*] The practice now at the Board is not to read the engineer's tender before they proceed to open the other tenders, but to suppress that, and keep it to themselves sealed in the hands of the Chairman until the Board becomes a Committee; is that the mode of procedure?—That is now the practice to prevent its being known.

5727. Mr. *Ferrand.*] Is it your opinion as a member of the Board that the refusal of Mr. Ridley's tender has been detrimental to the interests of the ratepayers of London?—I think it has; I always thought that Mr. Ridley was very hardly treated, that was my own opinion as a member of the Board.

5728. Mr. *Tite.*] It appears that that was the act of the Board?—That was the act of the Board.

Mr. John Augustus Nicholay called in; and Examined.

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5729 *Chairman.*] You are Member of the Metropolitan Board of Works, are you not?—I am.

5730. Are the lowest tenders always accepted by the Board?—Generally speaking, but not always; there was a marked exception in Mr. Ridley's case.

5731. Did you consider that Mr. Ridley's securities and capabilities were undoubted?—I think so, because I stuck to him to the last, having an immense deal of experience, being an old member of the Marylebone Vestry, where we had very large contracts, and a very great deal of experience, and I thought that, in justice to any contractor coming forward, and proving his capability as giving undoubted security, assisted as that undoubted security was, by a gentleman who stands high in the profession, namely, Mr. M'Cormick, the rejection of Mr. Ridley's contract was unjust to him, and unfair to the ratepayers, causing an immense increase of expenditure in consequence.

5732. He offered to deposit the whole amount of his security, namely, 20,000 *l.*, did he not?—There was some hesitation about his security, and, pending the inquiry, he came forward at once, and said, "I deposit the money in hard cash at your bankers."

5733. Then why was his tender not accepted?—That problem remains to be solved; that is what I want to know, and what the public want to know, and the ratepayers of all the metropolis.

5734. Are you not a member of the Metropolitan Board?—I am.

5735. Then cannot you state to the Committee the reason why Mr. Ridley's tender was not accepted?—The majority decided against accepting it.

5736. Were you there at the time?—Certainly.

5737. Cannot you state what it was that influenced that majority?—I think that, in the first instance, of course, when we have a professional adviser, we place implicit confidence in him.

5738. Who is that professional adviser?—Mr. Bazalgette, and when we place implicit confidence in him, and have no reason to think otherwise than that we are justified in placing that confidence in him, of course his advice goes a great way, and if members of the Metropolitan Board will not exercise their own discretion, and are guided entirely by the professional advice tendered, of course that has a great influence.

5739. Do you mean to say that it was Mr. Bazalgette's influence that caused Mr. Ridley's tender to be rejected?—That is my impression.

5740. Was it before or after that time that the occurrence took place which is noticed in a printed letter of yours; namely, that it was discovered that Mr. Bazalgette was to receive 12,000 *l.* as commission on a certain contract at Odessa?—The cause of that letter appearing, was a previous letter appearing some weeks before, asking if it was possible that the occurrence detailed in my letter could be true; I waited for some of the representatives of that locality (that is Islington) to answer it, and as it was not answered I considered it a public question of such immense importance that I thought that I should be wanting in my duty if the public mind was not satisfied by having that answer.

5741. The question that I asked you was this; was Mr Ridley's contract rejected) in consequence of Mr. Bazalgette's influence) before or after it had become known that he was to receive the 12,000 *l.* commission?—Before.

5742. It was afterwards that you found out he was to receive the 12,000 *l.*?—Yes.

5743. That affair was referred to a Committee of your Board, was it not?—It was.

5744. Did that Committee report?—Yes.

5745. Can you state the nature of that report?—That report states that altogether under the peculiar circumstances, Mr. Bazalgette having undertaken to give his sole time and services to the Board for the salary that he receives, it was not quite in accordance with that arrangement that he should do business on his own account with other parties.

5746. Then did Mr. Furness obtain this contract before that committee of your Board had sat?—He did.

5747. Had this matter with regard to the Odessa contract been kept secret; were the members of the Board aware of it?—No.

5748. The result of that was, that the ratepayers had to pay 25,000 *l.* more than they would have paid if Mr. Ridley's contract had been accepted; was that so?—That seemed to be the amount of it.

5749. Were you opposed to this report of the committee?—Decidedly so; when I was asked to sign it, I said that I would sooner cut off my right hand than permit my signature to be attached to such a report.

5750. Did you consider that Mr. Furness was competent to perform the contract?—I thought that he was quite competent, from the experience that we had had of him in previous works. When we first took Mr. Furness he was an unknown and an untried man, and he did not furnish us with anything to assist us, and it was with fear and trembling that we accepted his contract.

5751. Was Mr. Furness's tender the lowest?—I thought the noble Lord was alluding to a previous contract, which he is now executing.

5752. Was that previous to this contract that he has taken for the Low Level Sewer?—Yes.

5753. And previous to this one?—Yes.

5754. You granted this contract with regard to the Low Level Sewer to Mr. Furness because he had executed the former works well; was that so?—Yes.

5755. It was not because you were aware of any works that he had executed of the same nature as the embankment?—No.

5756. It is stated in this report that the reason why the contract is not given to Mr. Ridley is that, although he had executed certain works in America, yet that the operations which he had conducted in this country were not of so great importance as the embankment?—The Committee thought so; but I do not think so. I thought that Mr. Ridley gave a satisfactory explanation; and, as a proof of it, the Board, without any hesitation, without receiving any explanation from him personally, at once accepted his tender, subject to the security being satisfactory on enquiry; and I think that the Board were perfectly satisfied, because they accepted his contract unanimously.

5757. Then, if I understand you rightly, you

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mean that the Board, in reporting that they did not give the contract to Mr. Ridley because he had not conducted operations of sufficient magnitude, and that they did not give it to Mr. Furness, because he had conducted such operations, were putting it on false grounds?—It was an afterthought; I consider, as your Lordship states, in very forcible language, that it was upon false grounds.

5758. Mr. *Tite.*] With regard to Mr. Furness, you stated, did you not, that two or three years ago he was an unknown man?—Yes; we took him because his tender was the lowest, and his securities were satisfactory.

5759. He did that work entirely to your satisfaction, did he not?—Perfectly so.

5760. And, therefore, if there was anything to his prejudice before, there is nothing now?—The Board was quite right in accepting Mr. Furness's tender.

5761. With regard to the tender of Mr. Ridley, were you present when he delivered the tender, and answered the various questions that were asked him?—I could tell by referring to the Minutes, but it is a matter of history; I was present on every occasion when Mr. Ridley appeared before the Board, and, I think, oftener than the Honourable Member was.

5762. The question that I was about to ask you was simply this, whether you heard that the statements that Mr. Ridley made on that day were not borne out by subsequent inquiries which were made by the committee?—I think that a doubt was expressed; and, in justice to Mr. Ridley, I must say that he had contracted and done a great deal of work under our contractors, and, upon making inquiries, we found that that work was conducted and carried out in the most satisfactory way possible, and to the satisfaction of our engineer.

5763. He was then a sub-contractor, was he not?—He was then a sub-contractor.

5764. Were you present at the meetings of the Board when the question whether they should take Mr. Furness' tender, or open the whole question, was discussed?—Yes; on every occasion I was present.

5765. Did you agree with the decision for not opening the question, or otherwise?—A burnt child dreads the fire; on a previous occasion we advertised, and it cost us a great deal more money; but I know that when the proposition was made to advertise, several members of the Board said that a proposition of that sort, after the ordeal that we had gone through, was quite out of the question, knowing that it would not be entertained by the Board.

5766. The Board did not think it desirable to take it into their own hands?—Just so; I was against it.

5767. Were you present when the discussion took place with regard to the arbitration clause?—Yes; that was as to Messrs. Bakers' contract.

5768. At the open Board, when the question of the arbitration case was discussed, and when it was determined that the Board should not abandon the principle that their engineer should have the whole and sole control of the matter, did you agree, or otherwise, with that opinion?—My opinion was, that the arbitration clause should have been granted, because that would have opened the door to so many more eligible contractors.

5769. You were in a minority, then, were you not?—Unfortunately, I am generally in a minority.

5770. With regard to the Odessa contract, that has been before most of the Vestries and district Boards, has it not?—Yes.

5771. What do they say about it generally?—I have told them that they ought not to petition Parliament about it, as they wanted to do, because it would be killing their own child; it was attacking local governments; I said, "Do not let us dirty our own nests." But, as regards the enquiry, I know that the ratepayers and the public generally will be delighted to find that the matter is being investigated by independent members of the House of Commons.

5772. In a general way, though, you say that you are unhappily often in a minority; you will agree with me, will you not, that the attendance at the meetings of the Metropolitan Board of Works is very ample, that matters are openly and fairly discussed there, and that every man has an opportunity of stating his opinion, be it what it may?—Quite so.

5773. And in that sense are you of opinion that the Board represents fairly those who send members to that Board?—I am.

5774. Lord *Fermoy.*] You have heard the evidence which has been given by Mr. Roche, with regard to the arbitration clause; do you agree with him, that the result of keeping that clause out of the contracts is that the ratepayers practically suffer great loss?—The absence of that clause shuts out a great many eligible contractors, no doubt.

5775. Practically, does it not amount to this; that if your engineer chose (merely putting it, of course, as a hypothesis) he might ruin any contractor?—Exactly. I venture to think that our engineer is armed with colossal powers for good or for evil, and of that, I think, the necessary consequence is the shutting out of so many eminent men. If there is a dispute, why should it be left to one engineer, no matter what his talents may be?—I think that arbitration would deal out justice even handed, and as a proof it, I believe it is not to be questioned that that clause shuts out some of the most eminent men that we have.

5776. Practically, therefore, it is a delusion, to say that your works are put up to public competition?—I think that it is delusive to the ratepayers; that is my opinion. As the Honourable Member for Bath says, that is not the opinion of the Board; the majority thought otherwise, but I give them credit for all that they have done.

5777. Mr. *Tite.*] Their proceedings are honest, although they may be mistaken?—Just so. There was one man that had done work for us, and I believe that the Board, in justice, thought that they would be doing him a great service not to entertain his contract, because he might injure himself by it. I am sure that is an act of kindness that you do not meet with generally in public boards.

5778. Mr. *Ferrand.*] Have you attended the meetings of the Board regularly, since you have been a member of it?—Yes.

5779. It has been stated by Mr. Ridley that Mr. Furness, the contractor, is bound, according to his contract, to use the Thames sand in carrying out a portion of his works; it is estimated that he would have to pay 6 *d.* a ton for that sand; but it is stated that, instead of using the sand, Mr. Furness, the contractor, is authorising people to shunt a large quantity of rubble and rubbish from

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from different works, for which he receives 6*d.* a ton from some persons, and 9*d.* a ton from others; have you ever heard this matter brought before the Board?—No; and I should be very pleased to know whether that sum is to go to the benefit of the Board, or to the benefit of Mr. Furness, because the public are suffering an immense deal of inconvenience, and there are very loud complaints of the traffic obstructing the public in all directions, to enable the contractor to get this shilling a load, or whatever it is.

5780. Have you not heard of this before?—No; I only heard of it this morning.

5781. Has Mr. Bazalgette, to the best of your knowledge and belief, ever reported upon this circumstance to the Board?—I don't recollect that he has.

5782. Are you aware that Mr. Webster is deviating from the lines which were laid out for carrying out the works under the contract which he has?—I have heard it hinted that such is the case.

5783. Was that reported to the Board by Mr. Bazalgette?—I do not recollect it, but it might have been.

5784. Have you ever heard it stated, that a certain reservoir which is 9¼ acres in area, is not made of the stipulated depth that it ought to be according to the contract?—I have heard it some years back. Mr. Leslie, a man who is exceedingly deep in figures, did go into that question, and he raised a great amount of objection about it.

5785. Has that been brought before the Board by Mr. Bazalgette?—No; not to my knowledge.

5786. Then is it your opinion that the statement is correct, that that reservoir is not of the proper size?—I cannot answer that question; of course, if I had been expecting to answer any such questions, I should have gone into my books of figures, and should have been able to answer the question very decidedly.

5787. Mr. *Hibbert.*] What reservoir is it that you speak of when you mention Mr. Leslie?—At the time when he was a member of the Board, he questioned the capabilities of the reservoir, but none of them seemed to agree with his notions.

5788. Sir *Joseph Paxton.*] Do you refer to the outfall reservoir at Barking Creek?—I think that both were discussed.

5789. Mr. *Hibbert.*] Then, did Mr. Leslie discuss them before they were made?—Yes; when they were planned.

5790. Have you any Committee appointed by the Board to look after the Embankment and Drainage Works?—There is a Committee which sits from time to time, but I do not think that they look after it much.

5791. Do this Committee ever go over the works themselves?—I never was called upon to go over them.

5792. If you had a Committee to look after the Thames Embankment, would they not have discovered that this rubbish was being put there in place of sand?—They ought to have discovered it if the Committee had been called upon to inspect and view it.

5793. It appears, according to the stipulations, that the Metropolitan Board of Works were to require the Conservators of the River Thames to find this gravel; do you know whether the Board of Works have ever made any application to the Conservators for that purpose?—I do not think that the Board did, as a Board, and I do not know whether they were authorised to do it; but they might have done it without my knowledge, for since so much business has been thrust upon the Board of Works, it is impossible to attend all those Committees. When that Board was brought into being, it was merely to manage the sewage of the Thames, and then it was manageable, and I did attend the different Committees; but when you hand over to us the embankment, which we were never called upon or expected to deal with, when you hand over to us the gas and all those other matters, and when you are anxious to hand over to us the fire brigade, and when, if report speaks true, even the penny boats are to be handed over to the Board of Works, I defy any man to attend to such a multifarious amount of business, and to attend so many committees, three-fourths of which he knows nothing about.

5794. Mr. Bazalgette stated, on the last meeting of the Committee, that there has been a difficulty in getting gravel from the Thames Conservators; has that ever been brought before the Board or before the Committee of the Board?—It has not been brought before the Board, I think. I fancied that the object was twofold; first, getting gravel from the bed of the river, so as to deepen and improve the river; and, second, to get a solid concrete which would be useful for the embankment itself; because, if you allow the contractor to accept a premium for permitting every kind of rubbish to be used for the purpose for which the gravel was to be used, you lose sight of one of the great objects in view, which was to deepen the bed of the river, and get a current of the force which is sought to be obtained.

5795. Has any application ever been made to the Board to allow this rubbish to be shot into the Thames?—I think not.

5796. Sir *Joseph Paxton.*] Did you not state that all these works had been thrust upon you?—By Government they have been.

5797. With regard to the Thames Embankment, was not the Metropolitan Board of Works most anxious to carry that out; and was there not some dispute between them and the City as to who should carry it out?—I do not think that we should ever have had the Thames Embankment if Father Thames that summer had not made himself so offensive, that Members of Parliament were so frightened, that what the Board was anxious to attain was at once, in self-defence, thrust upon them by Parliament.

5798. But they were desirous to get it, were they not?—It is a great public improvement, that was not only sought for, but which, I think, will be a credit to the country; and the Board, I think, were very anxious to place themselves at the disposal of the country.

5799. The cost of that work is not paid out of the rates, is it?—No.

5800. Mr. *North.*] You have stated, and one of the other witnesses has also stated, that the carting in the streets has caused great obstruction and difficulty?—Yes.

5801. Must not this stuff have been carted away to some place in any case?—Yes; but I think that a continuous traffic, interrupting the Strand and all the streets down to the river, is very inconvenient. It would have gone, no doubt, in various directions, and not in one continuous line.

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5802. Then you do not take into consideration the greater distance for which it must have been carted if it had not been thrown into the river?—I think that if it were divided it would not be so inconvenient, when one load goes to one place, and another load to another place, and at different times; but where there are a continuous number of trains on one railway, it causes a great amount of impediment. It is what we complain of by Pickford's vans in our own streets in Marylebone; we say that it destroys the traffic, without our deriving any benefit from it.

5803. Then do you think that the continuity more than compensates in inconvenience for the greater distance of streets which would be travelled over if the rubbish were carted elsewhere?—Where it is continuous it is inconvenient.

5804. Mr. *Leader.*] Do you know why the Thames gravel was proposed to be used in filling up this embankment?—I know that when I have a contract (I have done a great deal of building) my architect always stipulates for Thames gravel to be used for the cement.

5805. But do you know the reason why that material was stipulated to be used?—I thought that the double object was to deepen the river, and to have a solid material for the embankment.

5806. Was not the object to deepen the river, and to compensate in water-space for the ground that is being taken away?—I thought so, certainly.

5807. Mr. *Cowper.*] At the time of the passing of the Act, was it not considered necessary that the river should be deepened, in order to supply the same water area, and to prevent its being diminished by the narrowing of the river?—Yes; we thought that the increased rush of water would remove all that was not solid obstruction, such as mud and everything of that sort, and that we should have a free current; of course the deepening would very much add to the strength of the current.

5808. Is it the practice of the Metropolitan Board of Works to invite tenders from all persons, without restriction?—Yes.

5809. Have you considered the advantage of inviting tenders only from a limited number of persons who are known to be competent, and then undertaking to accept the lowest tender out of the number?—They must be competent, because we only accept tenders subject to satisfactory security and inquiries. In Mr. Ridley's case there was a little difference. We had him before us, and we heard all that he had to say; and then, without any hesitation I think, we almost unanimously accepted his tender, subject only to inquiry as regards security. So well was Mr. Ridley satisfied that he said, "Gentlemen, I have immense resources, and I will put all my plant down, and in one week it will be in operation." I venture to think that Mr. Ridley was subject to a great deal of injustice in being received in such a unanimous way, without his being cautioned to wait until the Board really had decided as regards the security.

5810. By your present arrangements you are driven to inquire into the competency of the parties after they have tendered; do you not think that it would be better to make this inquiry before you issued the invitation to parties to send in a tender?—I think not, for this reason, that a contractor is apprised that the acceptance of his tender would be subject to security and to inquiry as to his competency.

5811. But is it not a disadvantage that by the present arrangement excuses are given for rejecting particular parties, whereas if you adopted the other method you would be bound to take the lowest tender, without exercising any discretion upon the matter?—It is merely doing beforehand that which we now do afterwards.

5812. Does not the present arrangement tend to throw a little suspicion and want of confidence upon the Board?—I think that after what has taken place it decidedly operates in that way, because when the Board unanimously accept a man's tender, and say, "We will inquire about your surety," he says, "Do not do that, gentlemen; if you have any doubt here is the money, and I will place it in the hands of your bankers." What respectable man will tender if his tender is refused after such straightforward dealing on his part? To show how little I am acquainted with Mr. Ridley, I may mention that I have never spoken to him, and that I never saw him until he made his appearance at the Board.

5813. Do you remember how many tenders were passed over on that occasion before they came to the tender of Mr. Furness?—I think that he was the fourth.

5814. Can you tell me the reasons for which the other tenders were passed over, after Mr. Ridley's had been passed over?—I never could make out why Mr. Ridley's was passed over; we thought that one gentleman's tender was so low that he would ruin himself, and the Board thought that they were doing him an act of kindness to refuse his tender. Then we came to Messrs. Bakers', and the Arbitration Clause shut them out; and then I think we came to Mr. Furness's

5815. Would you state why you thought it was advisable not to call for fresh tenders, instead of adopting the alternative of entering into a contract which was 25,000*l.* higher than the lowest tender?—I thought that we should not have got out of it so well with fresh advertisements. Take, for instance, the extraordinary fact, that in the case of the last tender that we have had to deal with, there is a difference of 90,000*l.* between the lowest and the highest, and that the lowest expects to get something very handsome out of it. We often find, in our little way at Marylebone, that contractors will arrange among themselves, and that the lowest in a fresh tender will be considerably higher than the highest in the original tender.

5816. Why should the fact of the lowness of Mr. Ridley's original tender have induced other parties on a former occasion to tender higher than he did?—I do not know; we only know what has taken place previously.

5817. Mr. *Tite.*] The object of the right honourable gentleman's question is this, whether we have discussed at the Metropolitan Board of Works the principle of a limited competition, or of an open advertised competition?—Open and advertised.

5818. You are aware that it has been discussed at great length, and that, by a very large majority, the Board have decided that open competition is the better course for a public Board to adopt?—I think so.

5819. But the point of an inquiry into that question has been deliberately entertained by the Board more than once, has it not?—It has.

5820. Lord *Fermoy.*] But you spoil the really open competition, and by leaving out the arbitration

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tion clause you make it extremely limited; is not that the case?—Yes.

5821. Mr. *Ferrand.*] Is it your opinion that if Mr. Bazalgette, your engineer, had recommended the Board of Works to accept Mr. Ridley's tender, it would have been accepted?—It was accepted. I do not know whether the Honourable Member's question is on the supposition that Mr. Ridley stood where Mr. Furness did.

5822. It has been stated by Mr. Roche that the Board did accept Mr. Ridley's tender, but that they afterwards received a report from Mr. Bazalgette, their engineer, recommending that Mr. Ridley's tender should not be carried out; is it your opinion that if Mr. Bazalgette had not objected to Mr. Ridley, his contract would have continued to have been accepted and carried out by the Metropolitan Board of Works?—That is decidedly my opinion. As I said before, the opinion of your professional adviser, in whom we have confidence (which confidence we have no reason to suppose to be misplaced), ought to receive that confidence from us that it undoubtedly does.

JOSEPH WILLIAM BAZALGETTE, Esq., called in; and further Examined.

J. W. Bazalgette, Esq.

5823. Mr. *Tite.*] YOU have some statements that you wish to make in explanation of some parts of the evidence which you gave on the last day of the meeting of the Committee; will you proceed to give those explanations?—In the first place, some questions were put to me with reference to the northern outfall reservoir. The questions to which I refer suggest, I think, that a larger sum had been paid for the works of the reservoir, which was not completed, than the total contract amount. I was not prepared to answer the question, coming upon me as suddenly as it did; but it will be seen, from the return which I have put in, that the contract amount was 164,000 *l.*, and that the amount paid up to the present time is 153,000 *l.*, leaving a balance of 11,000 *l.* in hand. The next point was with reference to the cubical contents of the reservoir, which I stated at 5,426,000 cubic feet, and it was suggested that the reservoir had not been constructed so large as that. Since that time I have sent down two independent parties to measure the reservoir, and the total cubical content of the reservoir is found to be very much in excess of what I stated to the Committee, the reason being that I gave the Committee the cubical content only up to the level of the overflow; but the total cubical content of the reservoir which can be made available by closing the penstocks is 6,485,000 cubic feet.

5824. Sir *Frederic Smith.*] How did that error arise?—It is not an error. I was giving the ordinary working of the reservoir when it would overflow at the weir; but on extraordinary occasions of rain, such as that discussion referred to, by closing the penstocks and filling the reservoir, it would hold 6,485,000 cubic feet.

5825. Mr. *Tite.*] Is that reservoir executed, as has been suggested, inconsistently with your drawings?—It is executed entirely in conformity with the drawings. I think it is six inches deeper; it is a little larger than the contract size, rather than smaller. The next point was as to the Cornish engines. I find that there were 27 designs sent in, when the Board advertised for any kind of engine with the prices attached to them, and those designs were referred to the Committee of Engineers, whose names I have stated to the Committee; 22 of those designs were for a different description of engines, and five were for Cornish engines; and the price computed for the Cornish engines amounted to 60 *l.* per horse power. Now, as we have constructed engines, at Deptford, for 44 *l.* per horse power, it is evident that the construction of the Cornish engines would not have been a cheaper arrangement, so far as the construction is concerned.

5826. *Chairman.*] Are you speaking of the Crossness engines or of the Deptford engines then?—It has reference to all the engines. I stated that the mode adopted to decide upon the kind of engines, there being a great controversy as to what was the best kind of engine, was to advertise for different engine-makers to send in the description of engine that they deemed the best, and to give the price for constructing those engines; and when those 27 designs were sent in they were referred to Mr. Robert Stephenson, Mr. Hawksley, Mr. Field, Mr. Penn, and other gentlemen. I stated that the cost of the engines at Deptford was 44 *l.* per horse power, and that the cost of the engines at Crossness was 90 *l.* per horse power, the price for the Cornish engine being 60 *l.* per horse power, which is dearer than our Deptford engines.

5827. Do you wish to explain why the one costs 90 *l.*, and the other 44 *l.*?—I should state that the Deptford engines were not designed by me, they were designed by Mr. Hawksley; but the questions which were put to me went to show that due regard to economy had not been had, inasmuch as we had adopted the double-acting rotating engines instead of the Cornish engines, and a reference to these facts shows that the engines that we have put up are cheaper, on the average, or as cheap as the Cornish engines. The next point is as to the number of contracts remaining to be let: I stated that the contracts remaining to be let would be three, probably they may be six; that is to say, I took the engines and engine-houses as one contract, but it seems not improbable that the engines of the engine establishment to be constructed may be let separately from the engine-houses. That will make five or six contracts instead of three, so that the total will probably be 31, instead of 29. I have furnished return of the contracts and of the amounts paid; but that return requires some explanations, which, from the short period which I have had for preparing it, I have not been able to give. I believe that some of the items include compensation and some other things of that kind. That has reference to my own evidence on the last day of the meeting of the Committee. I presume that I am not permitted to make any remarks upon points which have been raised to-day.

5828. Mr. *Tite.*] Have you any explanation to give on the evidence which you have heard to-day from the various witnesses, and which you desire to give for your own exculpation?—I have.

5829. *Chairman.*] Will you give that in writing?—I will.

Lunæ, 4° *die Julii*, 1864.

MEMBERS PRESENT:

Mr. Cowper.
Mr. Ferrand.
Lord Fermoy.
Mr. Hibbert.
Mr. Leader.
Lord Robert Montagu.
Mr. North.
Sir Joseph Paxton.
Sir William Russell.
Mr. Sclater-Booth.
Mr. Tite.

LORD ROBERT MONTAGU, IN THE CHAIR.

JOHN THWAITES, Esq., recalled; and further Examined.

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5830. *Chairman.*] WERE you unable to attend the summons of the Committee on last Monday, and again on last Thursday?—Yes; I had to postpone very important business in connection with the duty of an executor, in consequence of the pressing nature of my own duties; and I was obliged therefore, a week last Saturday morning, by the six o'clock train, to go into the north, and I was unable to return until late on Thursday night. I have to apologise to the Committee for not being able to obey the summons; otherwise, of course I should have done so.

5831. It has been given in evidence that the refusal of the Board of Works to insert an arbitration clause in the contract for the Low Level Sewer, and the Thames Embankment, had the effect of the Board losing a lower tender, namely, that of Messrs. Baker and Sons, than that which they ultimately accepted; is that the case?—It was not exclusively on the ground of the absence of an arbitration clause, but there were other conditions required by Messrs. Baker and Sons, prior to their being prepared to stand by their tender.

5832. Did they state that as one of the conditions?—That was one of the conditions, undoubtedly; the question of time was also another important condition.

5833. Can you state any other instances where the public have been prejudicially affected in the same way by the want of an arbitration clause?—I am not aware that they have in this case been prejudicially affected by it.

5834. Would not a lower tender have been taken, if that clause had been inserted?—Supposing that the other conditions had not existed, it might have been so.

5835. What were the other conditions?—One was the question of time; they were not prepared to execute the work within the time specified.

5836. Why was Messrs. Peto and Betts' tender of 97,523 *l.* for the Bermondsey Branch Sewer not accepted, when Messrs. Aird and Sons' tender of 107,000 *l.* was accepted?—For this reason, that they withdrew their tender.

5857. Why did they withdraw it?—That is within their own breasts; it was much to the annoyance of the Board.

5838. There was another tender, that of Messrs. Moxon and Company, for 99,875 *l.*, which was also passed over in favour of Messrs. Aird and Sons; can you explain that?—In reference to Mr. Moxon, I might state that he was one of the first contractors for the main drainage of the Northern High Level, and there was, in that case, a combination of circumstances; these were the enormous increase in the price of materials, a strike amongst the workmen, and other matters of that kind, which I fear entirely ruined Mr. Moxon, as a contractor; and, therefore, he was not in a condition to accept the contract, or we did not think it prudent to accept a contractor whose means were known to us not to be sufficient for the proper and energetic discharge of his duties under that contract.

5839. Then was it only because he had broken that his tender was not accepted?—Entirely; there was no objection to him personally.

5840. Were not his means at that time sufficient to carry out the one contract?—Not in the judgment of the Board.

5841. Did he not put in securities?—Yes, he suggested certain names.

5842. Were not those sufficient securities?—They were not for the execution of these works, because a tenderer for works of this nature requires to be in possession of a very large amount of capital to begin with; the plant in many cases would probably require an outlay of 20,000 *l.*, and they must have capital besides that to go into the market for materials. That is entirely independent of the amount of security.

5843. Had you ascertained that Mr. Moxon had not capital enough?—Clearly.

5844. In the competition for the Southern Outfall works at Crossness, why was Myers and Company's tender for 297,986 *l.* given on the 6th of March 1860, passed over?—There were but a very few pounds difference between Mr. Webster's tender and Messrs. Myers' tender.

5845. Mr. Webster is the present contractor, is he not?—Yes.

5846. Was not his tender for 300,000 *l.*?—Yes.

5847. Messrs. Myers and Company's tender was for 297,986 *l.*, was it not?—Yes.

5848. And Mr. John Ward's tender was for 278,400 *l.*, was it not?—Probably that was so.

5849. Why

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5849. Why were those two tenders passed over?—I think that Mr. Ward had never executed works of this character before. The Committee will understand that those were very difficult works involving very great risk, and requiring very great experience.

5850. Mr. Ward's tender was 22,000 *l.* less thon Mr. Webster's tender, was it not?—Yes, it is; and very difficult work indeed at the outfall, where they had to excavate probably 40 feet by the side of the river, and perhaps 20 feet below the bed of the river in a peat subsoil.

5851. Mr. Ward did not get the contract because he had never executed works of the kind before, was that the reason?—I believe that that was one of the reasons.

5852. Why did not Mr. Myers get it?—For the reason I have stated; that Mr. Webster had conducted his works so satisfactorily to the Board in materials and workmanship and despatch, that considering the very slight difference between Mr. Myers' tender and Mr. Webster's, we felt bound to give the contract to Mr. Webster.

5853. Has Mr. Webster ever executed works of that nature before?—If Mr. Myers' tender had been the amount of Mr. Ward's, his tender would have been accepted without question, because he is a large contractor, although he has never done works of this particular class.

5854. Why did you pass him over?—There was but a few pounds difference between him and Mr. Webster, and Mr. Webster had been the contractor to the Board, and had done works of a similar character; he had carried out the main sewer to that very point, and he was aware of the subsoil that he had to deal with, and of a variety of matters with which a stranger could not have been acquainted.

5855. Had Mr. Webster carried out works of that nature before?—I believe so; he constructed works for us down to that very point.

5856. Were those works of the nature of the reservoir, namely excavating close to the river?—Yes.

5857. For the Southern Outfall engines, why was the tender of Messrs. Watt & Co. for 44,900 *l.* accepted, while that of Mr. Hawthorn for 41,500 *l.* was passed over?—Simply because Mr. Hawthorn refused to guarantee the power of the engines in question.

5858. Did he refuse to guarantee the power of the engines that he constructed?—Yes.

5859. At the Deptford Pumping Station, why was the tender of Messrs. Aird and Sons accepted, which was 113,136 *l.*, while that of Mr. Strap for 104,285 *l.* was rejected?—All the tenders are of course the result of public advertisement; so soon as those tenders are received and opened, they are referred to a committee of the whole Board, for the purpose of considering them, and for the purpose of making inquiry as to the capacity of the party to execute the work, to his means and capital generally, as to the sufficiency of the sureties, and as to his personal experience in works of a like kind. In this case, in the inquiry which we made, we found that this person, Mr. Strap was utterly unequal to carrying out the contract. In advertising for tenders, you will easily imagine that persons who are not at all competent for the work, do sometimes put in tenders which are frequently perfectly wild as regards the amount for which they offer to execute the works.

5860. Then was Mr. Strap's tender passed over, because you did not consider him to be competent, in an engineering point of view, to execute the works?—There were other reasons; his capital was too small.

5861. In the case of the Southern Low Level Sewer, why was Mr. Webster's tender of the 20th February 1863, which was 234,000 *l.* accepted, while Mr. Ridley's for 215,000 *l.* was rejected?—I think that Mr. Ridley withdrew from that tender the same as Messrs. Peto & Betts did in the other case to which I have referred.

5862. Why did Mr. Ridley withdraw?—I do not know that he assigned any reason; he withdrew his tender, and there was an end of it.

5863. In the case of the Northern Outfall Reservoir, the date of the contract for which is the 27th of February 1863, Mr. Furness's tender to the amount of 164,000 *l.* was accepted, while Messrs. Eckersley and Baylis's for 131,000 *l.* was rejected, and Mr. Docwra's for 156,575 *l.* was also rejected; why were those two latter ones rejected, while Mr. Furness's was accepted?—Mr. Docwra declined to stand by his tender, alleging as a reason, that he had previously sent in a tender for some foreign works which had been accepted, and that he did not feel justified in taking more work at that time.

5864. Why was Messrs. Eckersley and Baylis's tender, which was 33,000 *l.* less than Mr. Furness's, not accepted?—They were very young contractors, and we found on inquiry that there were reasons why the Board should not accept them. In passing over that tender, the Board had regard to the insufficiency of capital, which is a very important element, and other questions of that kind; it was referred to a committee, and most carefully investigated.

5865. Who were their securities?—Mr. M'Cormick, a Member of this House, and Mr. Peter Eckersley, a relative of the contractors.

5866. You did not consider that their capital was sufficient, or that their security was sufficient?—No; nor were the sureties satisfactory.

5867. The contracts for the Greenwich and Deptford Sewers were given on the 7th of June, were they not?—Yes, that is a recent contract.

5868. Why was Mr. Dethick's tender for 22,940 *l.* accepted, and Mr. Meston's for 17,285 *l.* rejected?—On the 27th of May the tenders were received for 22,940 *l.* and 17,285 *l.*, but Mr. Meston withdrew his tender, alleging that he had made a mistake, and Mr. Dethick's was the next lowest tender.

5869. In the case of the Northern Outfall Reservoir, the contract for which Mr. George Furness has, there is a penalty, is there not, of 50 *l.* a day for every day that the work remains unfinished after the time specified, that is, the 31st of December 1863?—Yes.

5870. Are the works yet finished?—They are not quite finished.

5871. Then the penalties which Mr. Furness should pay up to the present time would be 9,000 *l.*, would they not?—I am not aware, not having made the calculation, but I have no doubt that your Lordship is correct. The Board have not yet enforced any penalties. The Board have, as a matter of precaution, inserted penalties for the due performance of the contracts, and to secure, if possible, the execution of the works within the time specified, but I am sure the Committee will feel that the Board must exercise some discretion in the enforcement of those

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those penalties; first, because there are cases of a mixed liability, where the Board, for example, has to place in the hands of the contractor certain works, or certain land for the purpose of carrying out the works; it may be, in some cases, that the Board are in a difficulty, and are unable to hand over to the contractor within the prescribed period the land, in order that he may proceed with his works. Delays frequently occur also from combination amongst the workmen. While the Board holds that penalty over the contractor in order to secure the execution of the works within the time specified, it becomes a very serious question whether the Board should enforce the penalty; and, furthermore, the Board must have regard to the fact, that if they were in the habit of enforcing this penalty the result would be, that parties tendering for their works would necessarily put a larger price upon those works, knowing that those penalties would be enforced, (supposing that the contractor had no control over the circumstances that had prolonged the execution of the works), and therefore it would recoil upon the Board ultimately by their receiving larger tenders in the event of the Board habitually enforcing those penalties immediately they were due. Of course, I say this without admitting any relaxation of the power of the Board, but we hold that power at our discretion, and we must have regard to all the circumstances of the case in considering whether or not those penalties should be enforced.

5872. Is there a penalty clause in each of your contracts?—Yes.

5873. In the Return, which you have handed in to the Committee, I perceive that you have not yet exacted any penalty under any contract?—We have not.

5874. But in most instances the works have not been completed until after the time specified has elapsed?—Mostly so.

5875. Is it the fact that in no instance have you imposed the penalty under the contract?—We have not at present imposed any penalty.

5876. In the contract for the Northern Outfall Reservoir, 10,000 *l.* is included for extra works, besides large quantities of provisional materials; is that usual?—That is usual, and it has been very deliberately determined by the Board, in all cases, that such a provision should be made. It was the practice of the previous Commissioners of Sewers to insert an amount of money for additional works, supposing that those additional works should be rendered necessary, and we have a general clause in the specifications that the works added are to be paid for; and that the works not done are to be deducted. Now, the only object that the Commissioners of Sewers had, and the only object that the Board of Works have, is for the engineer to give to the Board itself, and for them to give to the public, sufficient information as to the ultimate cost of those works. And, therefore, after estimating upon a fair valuation, the quantities of the works in question, there are cases where the depths of the foundations and the quantity of concrete have to be so greatly increased, and it is so often necessary to substitute one material for another, in consequence of the nature of the subsoil through which we pass, that it was thought desirable (and the Board have from time to time considered that point, and have never reversed the former practice) that a money value should be included in the tender, so that the Board may have some notion as to the ultimate cost of those works. It is a kind of contingent amount, subject, of course, to a schedule of prices for any additional works, or to a deduction in the event of any works not being done as specified.

5877. The provisional quantities are of such a nature that if the extra work is done, the extra amount of brickwork, for instance, should be paid for according to the Schedule at the end, and so with regard to wood work and everything else; is not that so?—Yes.

5878. But, besides those provisional quantities, there is also a provisional amount of money for extra works; why are both those provisions necessary?—One is for the information of the Board. The estimates are generally considered full, but to cover unforeseen contingencies, a certain per-centage (perhaps 10 per cent.) is added by way of an amount in the contract, so that the Board may judge as to the ultimate cost of those works, as far as any human foresight can inform them; the other has reference to the contractor pointing out the nature of the materials, and so on; and, of course, if the extra works are not done, if no additional foundations are necessary, and no substitution of one material for another, then the amount of 10,000 *l.* or 20,000 *l.*, whatever it may be, is deducted from the payment to the parties.

5879. Have you ever deducted the amount for provisional quantities?—In most cases, unhappily having regard to the peculiarity of our works, they exceed, with some trifling exceptions, the estimates of the engineer; and the marvel is, having regard to the nature of the subsoil of London, and the difficulties that they have to contend with, that those amounts are not very greatly increased.

5880. Have you ever deducted the amount inserted in a contract for extra works?—I think we have in the Southern High Level Sewer; that was Messrs. Helling and Co's. contract, to which I have before referred; it was ultimately carried out by Messrs. Lee and Bowles, as Mr. Helling's sureties.

5881. Can you give me any other instance?—I do not remember any other.

5882. That instance which you have given was a contract to the amount of 217,000 *l.*, was it not?—£. 217,000.

5883. And the amount for extra works over and above the provisional quantities was 10,000 *l.*?—No doubt that is so.

5884. Was the contractor paid 207,294 *l.* 15 *s.*?—Yes.

5885. He was to complete the works in 20 months, was he not?—He exceeded the time undoubtedly.

5886. He was to complete the works in 20 months, and he took three years and three months about it, did he not?—Yes.

5887. Was the penalty enforced in that case?—No, it was a case of failure on the part of Mr. Helling; and Messrs. Lee and Bowles, as his sureties, instead of paying the sum for which they were bound, elected to carry out the works.

5888. Then there was only 294 *l.* 15 *s.* paid for extra works in that case, over and above the provisional quantities?—Probably not.

5889. You alluded to Mr. Moxon's contract for the Northern High Level Sewer; was there not a sum of 10,000 *l.* included in that for extra works?—I think so.

5890. And

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5890. And he not only got that sum, but he got also 23,170 *l.* 5 *s.* 7 *d.* over and above the amount of his contract? — The contract was 152,430 *l.* and he was paid 175,600 *l.* 5 *s.* 7 *d.*

5891. That is 23,170 *l.* 5 *s.* 7 *d.* above his contract, is it not? — Yes, but that includes additional works which were not included in his contract; for example, the termination of that contract was the River Lea, and instead of including the river wall, which was to some extent a very costly work, in the next contract to Barking Creek it was thought advisable that the party who constructed the sewer, should construct the river wall, and therefore those works were executed by Mr. Moxon under a schedule of prices, and the amounts were added.

5892. But did he not receive 23,170 *l.* above what he should have received?—Yes, for additional works. It would not alter the facts whether they were included in the second contract or in the first.

5893. The next contract on the list is that for the Northern Outfall Sewer: Mr. George Furness, besides receiving 40,000 *l.* for extra works, received 16,760 *l.* over his contract, did he not? —I am not able to say; I have 641,760 *l.* as paid.

5894. Was not his contract for 625,000 *l.*?—Yes.

5895. Is not that 16,760 *l.* above his contract? —Yes, that was for additional works.

5896. Yet the contract contained 40,000 *l.*, for extra works; so that he received 56,760 *l.* in addition to the extra quantities of materials provided in the specifications?—Yes, including the extra works.

5897. Instead of being two years about his work, was he not three years about it?—Probably so, but I am not able to say.

5898. Passing over a number of others, we come to Mr. William Webster's contract for the Southern Outfall Sewer; he received 10,648 *l.* 2 *s.* 6 *d.* above his contract, did he not?—That was so; the contract was 300,000 *l.* and the sum paid was 310,648 *l.* 2 *s.* 6 *d.*

5899. Did not that contract contain 45,000 *l.* for extra works?—Yes.

5900. So that in all he received 55,648 *l.* 2 *s.* 6 *d.* above what his original works would have cost?—Yes, there were additional works in that case.

5901. Did not Mr. Bazalgette, in his last monthly report, state that on Mr. George Furness's contract for the Northern Outfall Reservoir, work to the amount of 164,500 *l.* had been done? —The contract is to the amount of 164,000 *l.*, and the sum paid is 153,085 *l.*

5902. What I asked was this: did not Mr. Bazalgette, in his monthly report for June, state that work had been done to the amount of 164,500 *l.*? —Yes, that would probably be so, but there is a reserve on the amount; the Board do not pay up the amount of work done; it is necessary that the engineer should measure up the amount of work done, and 90 per cent. is paid on the work.

5903. But had Mr. Furness done any extra work?—Probably he has; it is not quite finished yet.

5904. His contract contains 10,000 *l.* for extra work, does it not, besides provisional qualities? —Yes.

5905. It has been stated that an expensive coffer-dam, which was included in the contract, has never been made at that Northern Outfall Reservoir; is that the case?—I can speak personally, having seen the coffer-dam myself, and after 125 Members of this Honourable House have passed over that coffer-dam and examined it, and I am prepared to put in a certificate to show that the coffer-dam has been constructed, and that something like 400 feet of it still exists; a coffer-dam is for the purpose of excluding the water during the construction of the works, and when that work is completed, of course the piles are drawn; it may be that we may retain those piles for other purposes, but a large portion of the coffer-dam itself still exists.

5906. It is still in the water?—Yes, it is there to be seen now.

5907. Mr. *Tite.*] About high water?—Yes.

5908. *Chairman.*] How far do the foundations of that Northern Outfall Reservoir go down into the ground?—I am not able to speak to that; that is a question which the engineer probably can answer, but I know that it is a very great depth.

5909. In the specifications they are bound to go down 21 feet below the Ordnance datum, are they not?—Yes, and if the nature of the soil should be such as to require a greater depth, of course that greater depth has to be paid for.

5910. You do not know whether they have been carried down to a greater depth?—I think that that is very likely; the subsoil is of a very treacherous nature, being principally peat.

5911. Do you not make yourself acquainted with those circumstances?—Yes, certainly, we have reports from time to time from the engineer as to the nature of the works.

5912. Can you not state whether those foundations have been carried 21 feet below that Ordnance datum or not?—I am not able personally to say that; of course, the Committee can easily imagine that in these large works I cannot carry in my head the depth of every wall that has been constructed, but I have no doubt that I can furnish the Committee with the fact as to the depth.

5913. The contractor in that case has received the full amount of his contract, has he not, if you subtract the amount for extra works? — Yes, clearly.

5914. We heard something on the last day of the meeting of the Committee with regard to the loss which the Board sustained when they re-advertised for tenders on a former occasion; that was the case of the Middle Level Sewer on the north side, was it not?—Yes.

5915. Did not Mr. Rowe take it first and Mr. Brassey take it afterwards?—Yes.

5916. It was in 1859 that you advertised for this work, was it not, in the first instance?—Yes; we received the tenders on the 17th of February 1860.

5917. Mr. Rowe's tender was for 264,533 *l.*, was it not?—Yes; it is very much below any of the other tenders.

5918. And Mr. Moxon's, the next highest tender, was 322,575 *l.*, was it not?—Yes.

5919. Then Mr. Rowe commenced the works, and was paid 11,205 *l.*, and failed?—Yes.

5920. Then the Board re-advertised, and the lowest of the new tenders, which was Mr. Brassey's, was 329,800 *l.*, was not that so?—Yes.

5921. Then there was a difference of about 7,000 *l.* between Mr. Brassey's tender and Mr. Moxon's tender?—Yes.

J. Thwaites, Esq.

4 July 1864.

5922. Do you think that this is quite decisive as to the expediency of never re-advertising?—It was considered so by the Board at the time. Of course, without at all reflecting upon the contractors, it is a notorious fact that they do understand one another in reference to these questions, when the estimates and the valuation of other parties are known; and if you re-advertise for tenders, those amounts are greatly increased; and that is the difficulty that the Board has had to meet. We are dealing with a number of tenders, which are the result of a public advertisement.

5923. Did you not state, that Mr. Rowe's tender was a great deal too low, and that he could never have accomplished the work for that amount?—I have no doubt that he was very much below the cost of the works.

5924. Then, when you re-advertised, you got a tender only 7,000 *l.* more than Mr. Moxon's, which was the next lowest tender, and that in a sum of 300,000 *l.*?—Yes.

5925. Do you think that that is a very strong case in favour of never re-advertising? — We have had some experience of contractors.

5926. Had you any other experience besides that?—Yes.

5927. What other case has occurred?—I am not able to point to it at this moment, but the matter has been most carefully considered from time to time by the Board, as representing the ratepayers, and their desire has been to get the works done at the lowest possible price.

5928. During the examination of one of the witnesses concerning the Thames Embankment, reference was made to this matter; was there in that case any necessity for re-advertising, as Mr. Ridley was not only competent, but willing to undertake the contract?—That is assuming the whole question that Mr. Ridley was competent.

5929. There were two objections made to Mr. Ridley, if I understand it rightly, namely, want of experience, and want of proper sureties? —Yes, and there were other reasons why the Board rejected Mr. Ridley's tender.

5930. Did you state any other reasons in the report?—No, I think not, for prudential reasons.

5931. What were the other reasons?—They were reasons reflecting on Mr. Ridley, which the Board in kindness to him suppressed, and which I should be very sorry to make public.

5932. Will you be good enough to state what the reasons were, because Mr. Ridley appeared not to be aware of them?—I must respectfully ask to be excused from answering that question, but if the Committee are still desirous of prosecuting that question further, I am prepared to give in the name of the firm who made the communication, and who of course would give evidence here on the subject.

5933. Mr. Ridley has made statements which are rather a reflection upon the Board of Works and upon the way in which they carry on their business; we wish to find out whether or not Mr. Ridley's statements are worthy of credit; and I do not think that you need show any particular kindness to Mr. Ridley. I ask you again what was the other reason, besides those which were stated in the report, for your rejecting Mr. Ridley's tender?—My answering the question may involve me in unpleasant consequences, unless the Committee are prepared to indemnify me against such consequences.

5934. Are you aware that no action can be taken on statements made in a Committee of the House of Commons?—I am not aware of that.

5935. What was the reason why you rejected Mr. Ridley's contract?—I feel a difficulty in answering the question, unless the Committee press it. I will give to the Committee the name of the firm who made the communication, and who will be prepared to give evidence upon that point; but I most respectfully ask the Committee that I should not be urged to make that statement myself, because I am quite sure that the Committee will feel the delicacy of my answering questions, and making statements that have been made in confidence to the Board, which have been sought in confidence, and which have been give in confidence. If those statements should be made public, it would at once shut the door against any further information being given to the Board upon any subsequent occasion, when we are inquiring as to the sufficiency of means, or the moral character, or the experience of parties; parties would naturally say if we give you information in confidence, and you make this information public, we must in future decline to give that information in reference to contractors. It is of the utmost importance that we should have information on a variety of points, and that information can only be asked and received in the strictest confidence; and I feel great difficulty in committing a breach of that confidence.

5936. Do you think that you ought to take a statement derogatory to a man's character and position behind his back, and let that statement, which is kept a secret, injure him in his prospects in the world?—Of course, it was influential with us, receiving that statement from his own employers.

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LETTER from Mr. *T. G. Baring* to the Chairman of the Committee.

Sir, Whitehall, 20 May 1864.

WITH reference to the instructions given by The House of Commons to the Select Committee on the Sewage of the Metropolis, to inquire into the effects of discharging sewage into brooks or rivers, I am directed by Secretary Sir George Grey to forward to you the accompanying copy of a letter which has been addressed to Viscount Palmerston, K. G., by the Chairman of the Metropolitan Board of Works on the part of the Board.

I have, &c.
(signed) *T. G. Baring.*

The Chairman of the
Select Committee of The House of Commons on
the Sewage of the Metropolis, &c.

LETTER from the Chairman of the Metropolitan Board of Works to the Right Hon. Viscount *Palmerston*, K. G., M. P.

My Lord, Spring Gardens, 12 May 1864.

MY colleagues have requested me to submit for your consideration the urgent necessity for legislative action in order to prevent the rapidly increasing pollution of the River Thames by the several towns and populous places on its banks above the metropolis.

In making the limits of the jurisdiction of the Metropolitan Board of Works conterminous with those of the Registrar General, the Legislature were guided by considerations irrespective of drainage areas or watershed lines, and consequently deprived the Board of the power of freeing the Thames from pollution by the several sewers and streams discharging into the Thames but having their course beyond their jurisdiction. So long as the system of house-drainage was unknown, and the population beyond the metropolitan area few and sparse, no inconvenience was experienced from this source; but the operation of the Health of Towns and Local Government Acts and the increase in the riverain population compels attention to their requirements.

In carrying into effect the provisions of the "Metropolis Local Management Act, 1855," and the "Main Drainage Acts, 1858–1862," the Board have already expended or undertaken works involving the expenditure of nearly 4,250,000 *l.*; and when these works are complete, no sewage-matter whatever will be discharged or suffered to flow into the Thames within the limits of the metropolis, to effect which provision has to be made for the drainage of 117 square miles, and for a population of upwards of three millions. But it will be obvious to your Lordship that these figures by no means represent all the sources contributing to the pollution of the Thames, whose supra-metropolitan basin comprises greater or lesser portions of 12 counties, and upwards of 50 towns and populous places, with a population of more than half a million, the whole of whose drainage is discharged at present into the stream above the tidal influence, and consequently in a more or less concentrated form. Doubtless, at the present time, the sewage of Hampton, Chertsey, Staines, Eton, Windsor, Maidenhead, Marlow, Henley, Reading, Wallingford, Abingdon, and Oxford do not materially affect the metropolis; but it will be well to remember that in 1852, by the Metropolis Water Act, the metropolitan water companies were prohibited from taking their supply below Teddington Lock, and they consequently made arrangements for taking it from the Thames at Thames Ditton and Hampton respectively, and that with that supply the drainage of the towns above enumerated is being distributed to the consumers—a source of pollution which will become more and more serious as these towns avail themselves of the benefits of an improved system of house-drainage.

But if their sewage is at present sufficiently diluted to become innocuous before reaching London, such cannot be said to be the case with that of Kingston, Teddington, Twickenham, Richmond, Isleworth, Brentford, Chiswick, Croydon, and many others, whose contribution to the cloacal stream will become, both absolutely as well as relatively, greater year by year, and as the Main Drainage approaches completion. To provide a complete system of interception for the whole of the towns and villages at present discharging into the basin of the Thames would obviously be far too costly a burden to impose upon them, whilst it would be clearly impossible to shift their duties upon other shoulders: but my colleagues believe that the resources of modern science present other solutions for such a problem than that of interception.

Various suggestions have recently been laid before them and are still under their consideration, for the application of the metropolitan sewage to the purposes of agriculture. The peculiar conditions of the metropolis, and the magnitude of the questions involved, present obstacles difficult to be overcome. These conditions do not apply to the places abovenamed, many of which are very favourably situated for carrying out the suggestions referred to. I would therefore submit to your Lordship that the time has now arrived for the legislative prohibition of the discharge of sewage into the Thames by any town or village above London; they will then be compelled to provide some other means for getting rid of their drainage. In urging the justice of such a prohibition, I may observe that before the rise of modern sanitary legislation, the pollution of streams was an offence involving penal consequences, and the discharge of soil or filth from house-drainage, either directly into the River Thames or by means of any of its tributaries, was prohibited by the corporate authorities and by the several Commissioners of Sewers. The improvements in our domestic arrangements and the increase in the supply of water compelled other means of outfall than those afforded by cesspools, and now a quasi-legislative sanction has been given to the discharge of all the excreta of our population into our streams and rivers. The evils from that sanction threaten to become as great as those which it is its object to remove; we submit therefore that Parliament should exercise its authority to provide a remedy. We urge our claim to relief by way of compulsory legislation the more strongly in that we have been compelled by Parliament to expend 4¼ millions in doing that which we now ask that our neighbours should be called on to do.

I have, &c.
(signed) *J. Thwaites*,
Chairman of the Metropolitan Board of Works.

The Right Honourable Viscount Palmerston, K.G., M.P.,
&c. &c. &c.

Appendix, No. 2.

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LETTER from the Duke of *Northumberland* to Lord *Robert Montagu*.

Dear Lord Robert, Syon, Brentford, 7 June 1864.

I HAVE the pleasure of sending you the report on Alnwick Sewage, from the bailiff of the district; pray make whatever use of it you please.

Very truly yours,
(signed) *Northumberland.*

The Lord Robert Montagu.

MEMORANDUM as to the use of TOWN SEWAGE at *Alnwick, Northumberland.*

THE town of Alnwick having been systematically sewered, it was thought desirable to ascertain by experiment the value of the sewage for agricultural purposes, and irrigation works were carried out and prosecuted by his Grace the Duke of Northumberland during six years.

The operations were detailed in a paper prepared for the Newcastle Farmers' Club in 1862, in which year the trial was given up, because the occupiers of land thought it did not pay, although for the latter three years the Duke bore two-thirds of the working expenses; the pumps and pipes in full repair were left, with leave to the tenant on whose land they stood to use when he chose, but he has never done so.

There is no doubt that the diluted state of the sewage was the cause of failure; the situation, grass land on a sandy subsoil, was favourable, but the cost of pumping was too great to obtain a commercial return in produce. Had the outfall sewer allowed application by gravitation, the result would probably have been more satisfactory.

In a preliminary experiment by gravitation, the expense was only 15 *s.* per acre, including the cutting of distributing channels, although the quantity applied was very large.

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In consequence of the serious visitation of cholera to the town of Alnwick in 1849, steps were taken to bring the place under the control of the General Board of Health, and an inspection of the district was made by Mr. Robert Rawlinson, one of the inspectors of that Board. The result of his report was the formation of a local Board of Health for the townships of Alnwick and Canongate, which proceeded to make arrangements for systematically sewering the town and supplying the inhabitants with water. These operations were carried out in 1852 and 1853. During their progress difficulty and discussion arose as to the best mode of getting rid of the sewage, stimulated by the publications of the General Board of Health, which set forth in glowing colours the advantages of utilising the material, either by precipitating the solid contents or applying the liquid direct to the soil. Under the directions of his Grace the Duke of Northumberland, careful inquiries were made as to the various works of the kind which had been brought into operation; and though none of them bore directly on town sewage under the circumstances of Alnwick, it was hoped information had been obtained sufficient to guide the maturing of a plan for applying Alnwick sewage to the growth of crops. The townships of Alnwick and Canongate (forming, with slight exceptions, the town of Alnwick) contained, in 1851, 6,393 people. In 1861 the population had only increased one hundred. The whole sewerage of the town is concentrated in one outfall; but, from the peculiarities of the site, it had to be delivered at a low level, a few inches above that of the River Aln, and not available for application to the surface by direct gravitation. Any scheme, therefore, implied the cost of pumping. Mr. Rawlinson estimated the quantity at 100,000 gallons in 24 hours, and to lift such a quantity required very powerful machinery. The proposition first entertained was to form two tanks on the hill, 150 feet above the river, holding 40,000 gallons each, and to lift the sewage into them by water-power, afterwards distributing by gravitation. The size of tanks was determined from the accounts then published, stating the quantity to be applied to be about 40,000 gallons to 10 acres, and it was intended the water power should fill one while the other was emptying. This scheme was eventually given up on account of the large estimated cost of tanks, and the evident waste of power in raising to a height of 150 feet liquid to be applied at one-third or one-fourth of that elevation. In 1855 a plan was matured and carried out as follows:—A tank was formed at the mouth of the sewer, 40 feet in length by eight in breadth and seven feet deep, capable of containing 12,000 gallons, being the quantity estimated to keep the pumps going for two hours, to provide for the contingency of these gaining on the supply at certain times of the day. This tank was connected with the pumps at Denwick Waterside Steading, a distance of 400 yards, by a wind-bore or airtight pipe, four inches in diameter. At Waterside a steam-engine, of eight-horse power, was erected to work two pumps, with working barrels, five inches diameter, two feet stroke, and 25 strokes per minute, equal to 80 gallons per minute, or 48,000 gallons in a day of 10 hours. Cast-iron distributing pipes were laid down over 268 acres of land, with hydrants 200 yards apart, and gutta-percha hose provided for actual application. The following is a statement of actual cost:—

STATEMENT OF OUTLAY CONNECTED WITH DENWICK SEWAGE IRRIGATION.

	£.	s.	d.
Preliminary expenses, surveys, &c. - - - - - - - - -	31	17	2
Labourers, cutting drains, laying and jointing pipes, and material for the same - - - - - - - - - - - - - -	77	11	10
Cast-iron pipes, junctions, air vessel, valves, &c. - - - - - -	604	1	4
Cost of tank at outfall of the sewer - - - - - - - -	30	13	11
Cost of gutta-percha hose, &c. for distributing liquid - - - - -	60	6	2
Cost of engine, eight-horse power - - - - - - - -	125	–	–
Cost of pumps, and machinery connected therewith - - - -	46	1	5
Cost of building house for engine, machinery, and pumps - - -	104	8	2
TOTAL Outlay in 1855 - - - £.	1,080	–	–

On the 24th July 1855, the wind-bore and pumps were successfully tested, but the regular system of irrigation pipes was not got into play until the autumn, and interruptions from accidents to machinery prevented any systematic application of the sewage until the spring of 1856. Much of this year being cold and wet, it was unfavourable to the experiment. Still the results were considered, on the whole, satisfactory, apparently evidencing the valuable nature of such a resource in a dry spring and summer. The following notes were drawn from personal observation, and the statement of the tenants at the time:—On Denwick Waterside Farm there were about 54 acres irrigated during 32 days, giving, on a calculation that the pumps raised 48,000 gallons per day, an application of 28,980 gallons per acre. The pasture land, about 44 acres, did not, in consequence of the continual rains, show such marked improvement as was expected, but it was observed that both cattle and sheep gave a preference to the portion irrigated three or four days after the operation. A small field on this farm was mown for hay. It was twice watered, and was grazed by cattle up to the 22d May, being mown the beginning of August, when it produced about 3½ tons per acre, fully a ton per acre more than the field would otherwise have produced, besides keeping six large oxen up to the 22d of May. About 1½ acres of haugh-land were sown with Italian ryegrass, which was three times cut, and, with the aid of a small quantity of bean-meal, fed off eight head of cattle. A limited extent of land under turnips and barley was also irrigated, but we cannot state the exact results. Turnips improved greatly; they made a rapid growth after being irrigated; and, doubtless, but for the wet season the advantage would have been more evident. A larger area would have been watered but for the fear that the excess of liquid, artificial and natural, would drive the plants to seed, instead of increasing the bulbs. As to the barley, it is impossible to give a fair report, it was so much laid and injured by the continuous rains, which had so serious an effect on the harvest generally in this neighbourhood.

On Bridge End Farm four days were spent in irrigating about eight acres, which the tenant selected as the bare parts of the field; the result was that one part of the field was as good as the other, but being a wet season, favourable to this sandy soil, no correct conclusion can be drawn.

On Golden Moor Farm twelve or thirteen acres were irrigated (five acres of new land hay, and the rest pasture) without any marked difference. It happened to be heavy rain at the time of application, and the tenant observed the sewage running off by the drains, but whether materially changed in its components parts or not was not ascertained.

On the Pasture Farm about 40 acres were done, the result being generally good. Four acres were mown for hay, in which there was improvement, but no account of the quantity was kept; the remainder was in pasture, and the tenant considered it enabled him to keep a score of sheep more than usual. Most advantage arose from the application early in March, whereby a good spring of grass was ready in the early part of April for the ewes and lambs. During the second year, 1857, the sewage was pumped for 70 days over 118 acres, averaging 28,475 gallons per acre.

On Waterside Farm—On Clover Seeds.—The locks, 16 acres, 25 days, equal to 75,000 gallons per acre, cut three times about 6 feet of grass, but was not thick in bottom; supposed in consequence of the Clayport iron-water being used to flush the sewers for some weeks in the spring, while the clover was tender, without our being apprised, and consequent injury. On oats, North Wood Meadow, 6 acres, 4 days, equal to 31,000 gallons per acre, once over; bog land which readily burnt in hot weather, and the crop would all have gone off but for irrigation, will probably yield six old bolls per acre. On old grass for pasturage; grass banks, 20 acres; well close, 5 acres; bog close, 10 acres; in all, 35 acres, 18 days, equal to 30,400 gallons per acre; result, good effect, but not marked.

On Golden Moor Farm.—On clover seeds, five acres, four days, equal to 34,500 gallons per acre; on sea land, two acres, one day, equal to 24,000 gallons per acre; on old grass land, 20 acres, three days, equal to 7,200 gallons per acre. The tenant thinks there was no difference in the crop, as the application was nothing but water; has had as good from same land without any irrigation.

On Demesne Pasture Farm.—On old grass land, 20 acres, 10 days, equal to 24,000 gallons per acre, once over; little or no advantage this year.

On Bridge End Farm.—On old grass land, 14 acres, five days, equal to 17,144 gallons per acre: part done twice over, was hayed. Tenant says the latter part of the field was increased in quantity, but in consequence it was laid, and turned yellow at the bottom before it was cut, and therefore made inferior hay; the poorest land gave a fair crop, but nothing equal to the expense of application.

These results are not so satisfactory as was expected. There was no long duration of dry weather this season to develope the peculiar value of mere irrigation, and the extremely diluted state of the sewage seems to have prevented appreciable manure benefit, although in some cases the quantity applied was very large. The facilities afforded the town of increased water-supply tends annually to increase this difficulty. At first 12 gallons per head per day was estimated as the town consumption; it is now 23 gallons, and it is intended to bring a large additional quantity of water from Rugley Burn. The following figures, as showing the unexpected and excessive dilution of the sewage, are worthy of being recorded:—The original water-supply to the town of Alnwick was estimated at 12 gallons per head for 6,000 people, or, in 24 hours, 72,000 gallons; but Mr. Rawlinson said the sewage might probably give 100,000 gallons. By the recent application of the Local Board, it appears that, while the supply is yet deficient, they consume 23 gallons per head, or 138,000 gallons; while, at the same time, there has been, from May to October of this year, liquid issuing from the sewer at the rate of 140 gallons per minute, or, in the 24 hours, 201,600 gallons. Excess more than water supplied, 63,000 gallons. Of this quantity our machinery cannot lift more than 50,000 gallons per working day of 10 hours.

In 1858 the sewage was only pumped for 55 days, and without any decided effect. This we attribute to the excessive dilution of the liquid. There were no marked results on the grass land at Waterside, when the application was in the ordinary way of four or five acres per day, or 10,000 gallons per acre; but by forming a trench along the bank of a field, upwards of 90,000 gallons per acre were applied by gravitation, with a large increase to the pasturage, which also was preferred by stock, the sheep feeding close to the running liquid without any ill result. Half an acre of Italian ryegrass received the

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pumping of eight days, or at the rate of 768,000 gallons per acre; and after 24th May it produced three large crops, equal to about eight feet in length of grass, which was used for soiling cattle.

From the foregoing statements, it seemed evident that excessive dilution had proved the bane of the experiment. When operations first commenced there was not liquid to keep the pumps going steadily all the day; now the quantity before calculated on per day should be more than doubled, of course materially affecting the important question of cost per acre. This year the expense of applying averaged 10*s.* per acre, but the Italian ryegrass would cost for the half acre 5*l.* 3*s.* 6*d.* With a view to ascertain whether any arrangement could be made to pump at one time of the day, when less diluted, and reject at others, three samples were taken at different hours, and submitted for analysis to Dr. Richardson, of Newcastle, who gave the following report of the composition per imperial gallon in an—

ANALYSIS OF ALNWICK TOWN SEWAGE.—25 January 1858.

	9 a.m.	1 p.m.	4 p.m.
	Grains.	*Grains.*	*Grains.*
Ammonia - - - - - -	2·74	1·65	2·26
Phosphoric acid - - - - -	·64	·64	1·08
Alkalies - - - - - -	10·66	11·06	13·86
Total inorganic matter - - -	49·01	42·55	50·04
Total organic matter - - -	42·90	23·20	46·05

(signed) *Richardson and Browell.*

You will see that the portion collected at 1 p.m. is inferior to the others, both in the quantity and quality of its constituents, but not to such an extent as to justify you in rejecting it altogether. The sample at 4 p.m. is, on the whole, the best of the three; but the difference is not so great as we might have expected, and would not justify us in drawing any general conclusion. Under these circumstances, the Duke of Northumberland directed that enlarged machinery should be provided, and a trial should be made, for three years, to ascertain the result of a much larger application per acre. Accordingly, an improved boiler was put up, with 9-inch pumps, 12 inches stroke, and 24 strokes per minute, equal to 130 gallons per minute, or 93,600 gallons per day of 12 hours. The cost of these alterations, deducting allowance made for old boiler, amounted to 90*l.* 13*s.* 8*d.* The result is not favourable, partly from the conflicting interests of the tenants preventing them working together, but chiefly from loss of time in wet, snow, or frosty weather, fracture of machinery worked at a high pressure, and unsatisfactory results.

TABULAR STATEMENT OF TIME.

	1859.	1860.	1861.	Average.
Days worked in each year - - - -	104	137¼	127¾	123
,, lost by weather - - - - -	96	90	115¾	100*
,, lost in repairing machinery - - -	84	78¾	48½	70†
,, when engine was employed on farm works	8	7	19	11‡
Sundays and holidays - - - - -	48	52	54	52

* In 1859–60, long continuance of snow and frost; 1860–61, a favourable year, yet 90 days lost; 1861–62, a very wet year.

† Lessening in each year.

‡ Thrashing corn, &c.

Tabular Statement of Expense.

——	1859–60.			1860–61.			1861–62.		
	£.	s.	d.	£.	s.	d.	£.	s.	d.
Cost of engine working, &c. -	88	1	6	120	2	–	91	1	9
Giving as cost per acre - -	–	16	2	–	17	6	–	14	4
Total cost - - - - - -	130	1	6	162	2	–	133	1	9
Giving as cost per acre - -	1	5	–	1	3	8	1	–	10
Paid by the Duke - - -	91	1	6	108	18	4	85	3	8
Giving as cost per acre - -	–	17	6	–	15	11	–	13	4
Paid by the tenants - - -	39	–	–	53	3	8	47	18	1
Giving as cost per acre - -	–	7	6	–	7	9	–	7	6

Analysis of Working Expenses.

——	1859–60.			1860–61.			1861-62.			Average.		
	£	s.	d	£.	s.	d.	£.	s.	d.	£.	s.	d.
Repairs to engine pumps, boiler, and pipes - - - - - - -	34	17	9	18	14	1	12	6	3	21	19	4½
Cost of coal and leading - - -	23	3	11	40	13	1	31	15	9	31	17	7
Attendant on engine - - -	16	9	–	24	8	6	20	16	–	20	11	2
Attendants on hose and tank - -	10	8	10	25	12	9	18	5	6	18	2	4
Oil, candles, sundries - - -	3	1	11½	–	1	9	2	13	3	1	18	11¾
Tenant's interest on cost of engine -	-		-	10	11	10	5	5	–	5	5	6¾
£.	88	1	5½	120	2	–	91	1	9	99	15	–

From the foregoing figures it appears that the best average we could get was 123 working days out of the year, costing 1 *l.* 2 *s.* 10 *d.* per acre per day. The operations were entirely upon grass, and to justify such an expense ought to have given an extra ton of hay, or its equivalent in pasturage. As to this, Robson says that in 1861 he had a better crop, but nothing like half a ton. In 1860, irrigating in November and December set the grass growing in February, and the frosty cold weather of March finished it off for the rest of the year. In 1859, being rather late in putting on, the grass was beaten down, and never rose again. He thinks the money it has cost him expended in guano would have given much more satisfaction. Bradley and Davison are equally unfavourable in opinion, the latter stating that there was some benefit in dry weather, probably not more than pure water would have given. He left some ridges in hayfield, but when harvest time came saw no difference in the crop. Thompson, of Waterside, has been throughout most zealous, but his accounts are not greatly different from others. With regard to the land recently laid to grass, he observes, "very fair improvement," and "looked well in the spring,"—some light grass land "improved." On a portion of the haugh during last year he pumped two days per acre, and "as yet there is no evident difference from the rest of the field." Personal observation enables me to confirm these statements, and has strengthened me in the opinion that excessive dilution, and the necessary application of the manure unfermented, are the substantial causes of the failure of the scheme. When, as at Edinburgh, the liquid is floated on, the mere sediment ferments and manures, while the ground is so flat it is kept saturated for many hours. In all places where pumping on to hilly ground is practised, the liquid is in a concentrated state, as at Myre Hill, &c. Had the outfall of sewer been two or three feet higher, much of the haugh-land of Waterside Farm might have been irrigated by gravitation, in which inexpensive form alone, I fear, can any profit be expected. In the foregoing statements care has been taken to give a narrative of facts only, without staying to draw conclusions therefrom. It is evident that the failure has not arisen in details which were under control, but from "first principles," which the Denwick scheme, in common with many others, has not succeeded in reducing to practice. This observation is fully borne out by the Report just published by the Parliamentary Committee on the Sewage of Towns. Much of the evidence and experience there given would, with the alteration of name only, apply to Denwick. Thus our experience quite coincides with the statement that large

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increased produce is to be had when the application is "regardless of expense"—witness the produce of Italian rye-grass in 1858, and the following summary of an experiment made by gravitation in 1854:—

EXPERIMENT made with *Alnwick* Sewage on the Meadow Ground in *Barneyside*, put on from the middle of April to the end of May 1854.

	£.	s.	d.	£.	s.	d.
Produce of land irrigated—						
Hay, three tons per acre, at 70*s.* per ton				10	10	–
Aftermath				1	5	–
	£.	*s.*	*d.*	11	15	–
Mowing and winning per acre	1	5	–			
Cutting channels and conveying sewage	–	15	–			
				2	–	–
Produce of an acre adjoining, not irrigated—				9	15	–
Hay, two tons per acre, at 75 *s.* per ton	7	10	–			
Aftermath	–	15	–			
	8	5	–			
Mowing and winning	1	–	–			
				7	5	–
PROFIT per acre by application of sewage water £.				2	10	–

At the time of this experiment only a small portion of the house-drains, &c. were connected with the sewers, and therefore increased results were hoped for afterwards. The quantity applied must have exceeded half-a-million gallons. It is evident that, in common with other pioneers in this inquiry, we underpiped too much land; had we restricted the area, the saving of capital in this respect would have been considerable: 100 acres might have been laid out at a low level, only requiring the sewage to be raised 10 feet, instead of from 60 to 80, and consequently allowing a larger application by the same steam-power and working expenses. Again, as before observed, the best information we could get when the works commenced pointed to an application of under 10,000 gallons per acre, while in the Rugby experiments favourable results are said to be obtained of 3,000 to 9,000 tons per acre, or 670,000 to 2,000,000 of gallons per acre. The former is spoken of as a moderate application, but to use such a quantity at Denwick would cost 18 *l.* 15 *s.* per acre, requiring six tons of hay, or their equivalent, to repay cost. In the same Report the sewage at Watford is put at 60,000 gallons per day from 4,000 inhabitants, and is spoken of as too much diluted for use. Alnwick, as already stated, throws off 200,000 gallons from 6,500 inhabitants, being nearly cent. per centum more diluted; therefore, to obtain the like results, double expense is required, cutting away any profit at once. Lord Essex applies 12,000 tons, or 267,000 gallons per acre, at a cost of 1 ¼ *d.* per ton, or 6 *l.* 5 *s.*; this at Alnwick would cost 1 ½ *d.* per ton for double the weight, or 15 *l.* per acre, or five tons of hay; and his Lordship expresses an opinion that, to realise a return on capital embarked, the application ought not to cost more than three farthings or a penny per ton. When so excessively diluted, it is evident a considerable part of the soluble ammonia will pass through the land with the liquid, while the mineral manure is left behind in the shape of sediment. In anything like the quantities now spoken of great practical difficulties must arise in applying sewage to tillage land. In our limited experiments the turnips were much "trashed" in manipulating the hose, and the soil torn up by the force of the liquid. On a loose, sandy, or gravel soil, to turn a rivulet upon it would wash the seed away bodily. This tends to limit the application to grass land, and even in this satisfactory results will only be obtained when the market enables a large quantity to be cut for green food. The hay, in such a bulk as anticipated by the Rugby experiments, will be very difficult to win, a serious question in our uncertain climate, besides the probably coarse quality, and loss of quantity in drying.

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LETTER from Mr. *Hammond* to Lord *Robert Montagu.*

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Mr. Hammond presents his compliments to Lord Robert Montagu, and has the honour to transmit to him, for the information of the Committee of The House of Commons upon the Utilisation of Sewage, the accompanying extract from the "Moniteur," which has been received from Her Majesty's Ambassador at Paris, containing a report by M. Béhic, upon Manure.

Foreign Office, 4 June 1864.

RAPPORT à l'Empereur.—Paris, le 2 Juin.

Sire, Paris, le 1er Juin 1864.

Pressée par les exigences d'une consommation toujours croissante, l'agriculture a dû chercher les moyens d'augmenter sa production et d'en réduire les frais. A défaut des engrais provenant du bétail, qui ne pouvaient se multiplier à l'infini, elle s'est attachée à l'emploi de toutes les substances qui possèdent des qualités fertilisantes.

Le guano, la poudrette et l'engrais humain, le noir animal, les os, les cornailles, les débris d'équarrissage, les chiffons de laine, les tourteaux, les résidus de la raffinerie et de la distillerie, les cendres et charrées, les cendres pyriteuses, les engrais marins, ont été successivement mis à contribution pour accroître la productivité du sol. Enfin, un engrais récemment connu, le phosphate de chaux, tend à prendre place parmi les substances les plus utilisées comme remplaçant des os et du noir animal.

D'après les renseignements recueillis dans une enquête prescrite par mon prédécesseur, la consommation annuelle des engrais artificiels dépasserait dès à présent, en France, cinq cent millions de quintaux métriques d'une valeur d'au moins 500,000,000 de francs; 67 départements feraient de ces substances l'usage le plus étendu, et il n'en existerait que 6 où leur emploi serait absolument ignoré. Malheureusement, si la chimie a favorisé la vulgarisation de ces utiles substances en révélant le secret des manipulations que la plupart d'entre elles exigent pour être employées, beaucoup des nouveaux engrais sont des poudres que rien ne caractérise à l'œil. Aussi, abusant bientôt de l'ignorance des cultivateurs, la mauvaise foi la plus grossière, à l'aide de mélanges sans valeur, est-elle venue adultérer les produits fertilisants.

Les conséquences de ces fraudes ne doivent pas se mesurer seulement aux chiffres qui viennent d'être soumis plus haut à Votre Majesté. A la perte de la valeur d'achat de l'engrais falsifié et inerte, il faut ajouter celle de la valeur des semences, du montant de la main-d'œuvre pour les façons données à la terre, et enfin le loyer du sol où l'engrais a été répandu.

La fraude peut porter sur la nature même du produit, sur sa composition ou sur sa qualité, sur la quantité ou sur l'origine de la marchandise vendue. Dans ces différents cas, la législation actuelle est loin d'avoir donné à l'acheteur toutes les garanties dont un grand intérêt public conseille de l'entourer.

En effet, si la fraude touchant la quantité, fraude grossière et facile à saisir, est punie de peines portées par l'art. 1er de la loi du 27 Mars 1851, si la tromperie sur la nature de la marchandise est atteinte par les dispositions de l'art. 423 du code pénal et de l'art. 8 de la loi du 23 Juin 1859, la tromperie sur la composition et sur la qualité ne sont atteintes par la loi, suivant la jurisprudence en vigueur, qu'autant que l'altération est tellement considérable qu'elle rende la substance absolument impropre à l'emploi projeté. Quant à la fraude résultant d'une fausse indication de l'origine, elle ne peut donner lieu à poursuite. Enfin, il résulte de deux arrêts de la cour de cassation (1er Juillet et 30 Décembre 1859) que la mise en vente d'une denrée sous une indication fausse, quant à sa qualité et à sa composition, n'est point punie par la loi tant que la vente n'a pas été effectuée, et que, la vente même consommée, la tromperie n'est punissable que si elle porte sur la nature de la marchandise.

Frappés des abus qui existaient notoirement dans le commerce des engrais, sollicités par les vœux des agriculteurs qui demandaient ardemment une protection à l'égard de fraudes contre lesquelles ils étaient inhabiles à se défendre, plusieurs préfets ont tenté de suppléer par des actes locaux au silence ou aux lacunes de la législation générale.

A l'imitation du département de la Loire-Inférieure, qui en avait pris l'initiative dès 1837, vingt autres départements de l'Empire virent le commerce des engrais réglementé par des arrêtés préfectoraux, et l'enquête de 1862 constate que, par suite de cette réglementation, la fraude, sans cesser d'exister, avait été notablement réduite. Mais les actes dont il s'agit soulevaient, au point de vue de la légalité, des objections sérieuses. Il était en effet naturel de penser que, si la liberté commerciale, dont le principe est proclamé par nos lois fondamentales, devait être restreinte dans l'intérêt de la moralité, du bon ordre et de la prospérité agricole, c'était au législateur seul, et non à l'administration, qu'il appartenait d'apprécier l'opportunité et la mesure de ces restrictions. Tous les doutes à cet égard se sont d'ailleurs trouvés dissipés par les arrêts des 28 Août 1862 et 6 Novembre 1863, par lesquels la cour suprême a reconnu que la police des engrais rentrait dans la classe des objets confiés à la vigilance et à l'autorité des corps municipaux, et n'appartenait pas à la compétence plus générale des préfets. En l'état de l'industrie et du commerce des engrais, une telle décision équivalait à la négation de toute intervention administrative dans la police de cette industrie et de ce commerce.

De telle sorte, Sire, que la sincérité des transactions échappe aujourd'hui tout à la fois à l'action de l'administration par son incompétence, et à celle des lois par les lacunes qui existent dans leurs dispositions.

L'ordre public, la production générale, le devoir pour le Gouvernement de protéger la fortune de tous les citoyens, surtout de ceux que le défaut de ressources ou de lumières empêche de se protéger eux-mêmes, l'insuffisance reconnue des lois, tous ces motifs paraissent militer en faveur d'une législation nouvelle qui aurait pour objet d'arrêter les fraudes en matière de commerce d'engrais ou de substances fertilisantes.

Cette législation, dont le caractère devra être général et nullement particulier à telle ou telle partie de l'Empire, devra-t-elle être préventive ou simplement répressive?

Une loi qui, comme celle proposée en 1851 à l'Assemblée législative par MM. Jussereau et Dumas, et qui est celle à laquelle on s'est toujours rattaché, obligerait les marchands d'engrais à une analyse préalable et à l'étiquetage des matières mises en vente, aurait une utilité qu'on ne saurait méconnaître, et si l'étiquetage des engrais était fait avec sincérité et d'une manière authentique, les associations agricoles pourraient éclairer les cultivateurs, comme on le fait au secrétariat du Farmer's Club en Angleterre, sur le mérite des engrais et sur le degré d'efficacité qu'on peut s'en promettre, eu égard aux sols qui doivent les recevoir et aux récoltes qu'on se propose d'obtenir; on préviendrait ainsi beaucoup de dommages, de tâtonnements et de mécomptes.

L'avantage de dispositions légales ayant ce caractère ne saurait donc être mis en doute; mais elles constitueraient, on ne saurait le nier, une certaine atteinte au principe de la liberté commerciale, et c'est ici qu'on doit se demander si les intérêts qui sont en jeu sont de nature à légitimer une telle dérogation.

Il est à remarquer d'abord que le principe dont il s'agit n'a et ne peut avoir rien d'absolu.

Les restrictions apportées à la construction et à l'exploitation des établissements reconnus dangereux ou insalubres et même incommodes, les règles imposées à l'exercice de certains commerces tels que l'imprimerie et la librairie, le contrôle des bijoux et objets fabriqués en or ou en argent, sont autant d'exceptions au principe de la liberté commerciale, exceptions qui trouvent leur justification dans des raisons d'ordre ou même d'utilité sociale, et qui ont été de tout temps et sans réclamation consacrées par nos lois.

Les autres industries, par cela seul qu'elles sont libres, n'échappent pas absolument à l'action, même préventive, de l'administration. La loi des 16 et 24 Août 1790 investit les maires d'un droit de police qui leur permet d'imposer à toute industrie les règles ou les précautions qui peuvent être nécessitées par l'ordre, la salubrité ou la sécurité publics, de telle sorte que, si les mesures préventives adoptées par les préfets en matière de surveillance du commerce des engrais ont dû être condamnées par la cour suprême, ce n'est pas en vertu du principe de la liberté commerciale, mais en tant qu'imposées par une autorité que la loi n'avait pas investie de la compétence nécessaire.

La question, Sire, est complexe et délicate. Elle touche à un ordre de faits qu'on ne saurait modifier sans un mûr examen.

Il m'a semblé qu'il y aurait avantage à en confier l'étude à une commission qui serait appelée à donner son avis sur l'utilité et l'opportunité d'une loi destinée soit à prévenir, soit à réprimer les fraudes commises dans le commerce des engrais. Elle aurait notamment à examiner si l'atteinte qu'aurait à subir la liberté commerciale par la législation nouvelle serait suffisamment motivée par la nature et l'importance des intérêts à sauvegarder.

Cette réunion, qui comprendrait nécessairement des jurisconsultes, devrait renfermer aussi des hommes versés dans les sciences et les pratiques de la chimie et de l'agriculture. Elle serait saisie de tous les documents de l'enquête poursuivie en 1862, ainsi que des rapports auxquels cette enquête à donné lieu.

Je demanderai à Votre Majesté, Sire, si Elle daignait approuver la formation de cette réunion, de vouloir bien m'en réserver la présidence, et de la composer ainsi qu'il suit:

MM. le Ministre, Président.
Dumas, Sénateur, Vice-Président.
Elie de Beaumont, Sénateur.
Josseau, Député.
Heurtier, Conseiller d'Etat.
Lestiboudois, Conseiller d'Etat.
Bayle-Mouillard, Conseiller à la Cour de Cassation.
De Raynal, Premier Avocat Général à la Cour de Cassation.
De Monny de Mornay, Directeur de l'Agriculture.
Dailly, Membre de la Société Impériale et Centrale d'Agriculture.
Valette, Propriétaire dans l'Indre.
Tisserand, Chef de Division au Ministère de la Maison de l'Empereur et des Beaux-Arts.
Bella, Directeur de l'Ecole Impériale d'Agriculture de Grignon.
Boussingault, Membre de l'Institut, Professeur au Conservatoire des Arts et Métiers.
Hervé-Mangon, Ingénieur, Professeur au Conservatoire des Arts et Métiers et à l'Ecole Impériale des Ponts et Chaussées.
Al. Simon, Chef du Cabinet, Secrétaire, ayant voix consultative.
Porlier, Chef de Bureau, Secrétaire, ayant voix consultative.

Le Ministre de l'Agriculture, du Commerce et des Travaux Publics,
Armand Béhic.

Approuvé: NAPOLEON.

App. No. 3.

(Translation.)

REPORT to the EMPEROR.—Paris, 2 June 1864.

Sire,

AGRICULTURALISTS have been forced, by the necessities of an increasing consumption, to seek means for augmenting the amount and diminishing the cost of production. A deficiency of stable and farmyard manures, of which the supply is necessarily limited, has brought into use every other substance which possesses any fertilising tendency.

Guano, urinated lime, human fæces, offal, bones, horns, horseflesh from the knacker's yard, woollen rags, oakum, sugar-refiners' and distillers' refuse, cinders and charcoal, wood-ash, fish manure and seaweed have successively been pressed into the service of agriculture, and been employed to increase the productiveness of the ground. Lastly, a newly-discovered manure, phosphate of lime, has taken a prominent position among the most available manures, and bids fair to take the place of crushed bones.

According to the information received in an inquiry which was instituted by my predecessor in office, the annual consumption in France of artificial manure amounts to more than 223,214,286 tons, worth 20,000,000 *l.* Sixty-seven of the departments make a very extensive use of these substances; there are only six departments where their value seems to be ignored. Chemistry encourages the extended use of these substances, by teaching those inexpensive methods of manufacture which permit of their being generally employed; yet many of them are powders which have no distinctive character appreciable to the eye. The manufacturers, therefore, relying on the ignorance of farmers, have, with the greatest dishonesty, adulterated their manures by the addition of substances which have no value in an agricultural point of view.

The evil consequence of these frauds must not be measured by the statistics which I have just submitted to your Majesty. We should not only take into account the loss of the price paid for an adulterated and inert manure, but we must add to this the value of the seeds, the amount of labour expended in tillage, and the rent which is paid for the land to which these valueless manures have been applied.

These frauds may be committed, in regard to the nature of the manure—(1.) as to quality or composition; (2.) as to quantity; and (3.) as to origin. Our present legislation is far from giving to the consumer all those guarantees which a great public interest imperatively demands.

* * * * *

As the artificial manure trade notoriously abounded with such flagrant abuses, and as the entreaties of helpless farmers, who claimed protection against these frauds, were urgent, many of the prefects endeavoured, by local Acts, to supply the deficiencies and shortcomings in the general legislation of the country.

The Department of Loire-Inférieur took the initiative in 1837. Twenty others imitated this example, and regulated the artificial manure trade by means of prefectoral byelaws. The inquiry of 1862 proved that the result of these local regulations had been that the amount of fraud was manifestly decreased; yet these byelaws are open to very serious objections on the score of illegality. If the freedom of trade, which is a principle that is proclaimed in our fundamental Constitution, is to be restricted in the interests of morality, of order, and of agricultural prosperity, it may reasonably be asserted that it was the province of the legislator only, and not of the administrators of the law, to judge of the incidence and extent of these restrictions. All doubts on this point were, however, set at rest by the Orders of 28th August 1862, and of 6th November 1863, by which the Supreme Court laid it down that the supervision and regulation of the manure trade had been confided to the vigilance and authority of municipal bodies, and did not belong to the more general action of the prefects. This decision amounted to a denial of all administrative interference with regard to the manufacture and trade of artificial manures.

Thus, Sire, it is that these fraudulent transactions are not prevented by the administrators of the law, by reason of their incompetence, nor by the laws themselves because of certain defects in their provisions.

The course of order, the interests of producers, the duty of the Government to protect the property of all its citizens, especially of those whose poverty or want of knowledge renders them incapable of protecting themselves, the acknowledged insufficiency of the law: these furnish ample grounds for asserting the necessity of some new legislation which shall put an end to these frauds in the manure trade.

Should now this legislation, which must be generally applicable to all parts of the empire, be preventive or simply repressive? A law (like that which was moved in the Legislative Assembly of 1851 by M. Jussereau and M. Dumas, and is still binding) which would oblige the dealers in manures to submit their goods to a previous analysis and tabulation of constituent parts, would, beyond all doubt, be most beneficial; and if the tabulation were faithful and authoritative, then the agricultural associations would be enabled to inform farmers as to the relative merits of the manures, and the results which might be expected from the variety of soil to which they are applied, and the crops which they are to nourish. This would also prevent much injustice and loss, and put an end to many operations now carried on in the dark, which can only end in disappointment.

The advantage of some legal provisions of such a character could not for a moment be doubted; yet it cannot be denied, moreover, that they would constitute a violation of the principle of commercial freedom. It becomes a question, therefore, whether the interests which are at stake are of a kind which would warrant such an infringement of that principle.

We must bear in mind that the principle of commercial freedom never was, and cannot by any means be, absolute.

The restrictions imposed on manufactories, and works which are dangerous, unhealthy, or even inconvenient; the compliance with certain rules, which is required in the exercise of some trades, such as printing and publishing; the stamps on gold and jewellery, are all deviations from the principle of commercial liberty; and these deviations are fully justified on the grounds of order and public utility, and have from time immemorial received, without hesitation or dispute, the approbation of our legislative enactments.

Other industrial occupations, by reason of their being free, are therefore held to be not absolutely exempt from the interference and even preventive action of the administrators of the law. The laws of 16th August and 24th August 1790 give to mayors a right of supervision, and empower them to impose on every industrial pursuit, the regulations and precautionary measures which are required for the cause of order, or for public health and security; so that if the measures of prevention which were adopted by the prefects for the regulation of the manure trade had to be condemned by the Supreme Court, it was not in virtue of the principle of commercial freedom that they were condemned, but because they had been promulgated by those whom the law of the land had not invested with an adequate authority.

The question, Sire, is complicated and difficult: it concerns many cases which it is unwise to touch without mature investigation.

It seems to me, therefore, that the best course would be to entrust it to a Commission which should report as to the benefit and necessity of some law calculated to prevent, or at least repress, the frauds of the artificial manure trade. It would be the duty of this Commission to consider whether such a violation of commercial freedom would be sufficiently borne out by the character and importance of the interests which have to be protected.

The Commission should, of course, be issued, among others, to men learned in the law, and to persons well versed in the science and practice of agriculture and of chemistry. All the papers, documents, and reports, of the investigation of 1862, should be referred to this Commission.

Sire, I ask whether your Majesty will approve of the appointment of such a Commission, &c., &c.

Armand Béhic,
The Minister of Agriculture, Trade, and
Public Works.

Approved:

Napoleon.

LETTER from Mr. *Hammond* to Lord *Robert Montagu.*

My Lord, Foreign Office, 10 June 1864.

With reference to your Lordship's letter to Mr. Layard of the 31st ultimo, I am directed by Earl Russell to transmit to you herewith a copy of a Despatch which has been received from Her Majesty's Ambassador at Paris, on the subject of the regulations observed in France with regard to sewage.

I am, &c.
(signed) *G. Hammond.*

The Lord Robert Montagu, M. P.

LETTER from Earl *Cowley* to Earl *Russell.*

My Lord, Paris, 7 June 1864.

I have been in communication with the Department of Public Works on the subject of your Lordship's Despatch, No. 466, of the 1st instant, enclosing copy of a letter to Mr. Layard from the Chairman of the Committee of the House of Commons, on the utilisation of sewage. It appears that there is no general law in France on the subject of sewage, each town being allowed to make its own regulations in respect to it.

I have made inquiries of the legal adviser of the Embassy, who confirms this statement.

If I can be of any further use to the Committee, I beg to put myself at their disposal.

I have, &c.
(signed) *Cowley.*

Earl Russell, K. G.

Appendix. No, 4.

PAPER handed in by Mr. *Acland*, M.D., 13 June 1864.

MEMORIAL concerning the REGULATION and PURIFICATION of the THAMES WATERS.

App. No. 4.

1. WHEREAS the area of the Thames and its Tributaries may be computed to contain 6,000 square miles, and extends over parts of the several counties of Essex, Kent, Middlesex, Surrey, Hants, Berks, Wilts, Oxon, Bucks, Herts, Warwick, Northampton, and Bedford:

2. Whereas it is highly expedient to regulate the waters brought down by the River Thames, so that they shall be as fit for use and as little contaminated as may be, both in the district immediately above London and in the neighbourhood of all towns on its banks:

3. Whereas no systematic provision has as yet been made either for regulating the several branches of the waters in the Thames Basin on a common plan, or for deterring the towns on the several parts of it from casting their sewage into the streams; and whereas many towns situated above the metropolis, viz., Richmond, Staines, Windsor, Maidenhead, Henley, Reading, and Oxford do so cast in the whole or parts of their sewage:

4. Whereas it is admitted that besides the injurious pollution of the waters, waste accrues from the loss of sewage:

5. Whereas the unregulated action of floods inflicts damage on many lands adjoining the river, and is injurious to the health of the district:

6. Whereas it is certain that these evils would be greatly abated, and the public health improved by a more complete and systematized management of outfalls, dams, and sewers than is at present possible:

7. Whereas also a Report on the Thames Basin with reference to these several particulars would establish principles applicable to other river systems, and besides improving the water supply of the metropolis would yield much information bearing upon the public health and of service to the nation at large, and may properly be therefore esteemed a national object.

The undersigned solicit the Government to issue a Commission of Inquiry, or to cause full inquiry to be made in such way as they may see fit, into the condition of the Thames and its tributaries (the immediate district of the metropolis being excepted from such inquiry, as already under special jurisdiction); to inquire what defects exist; and to report what remedies can be applied to such defects; having regard generally to all purposes by which the river and its branches, or lands adjoining to them, may be improved; but specially to the purification of the Thames waters for the use of the metropolis and of the towns in the Thames district, as well as the amendment of the health of the population which adjoins them.

(signed)
Edward Sabine, President of the Royal Society.
Roderick Murchison, Director General of the Geological Survey.
Richard Owen.
C. B. Adderley.
William Heathcote, M.P.
George Graham, Registrar General.
William Farr, Somerset House.
Thomas Watson, President of the Royal College of Physicians.
**Neil Arnott*, M.D.
William A. Guy, King's College.
**R. Dundas Thomson*, F.R.S., Health Officer, Marylebone District.
James Clark.
**Robert Rawlinson*, C.E., Local Government Office.
Strzelecki.
**Marlborough.*
Radnor, Coleshill.
**Robert Throckmorton*, Buckland.
Carnarvon.
S. Oxon.
J. Randall, Archdeacon of Berks.
Francis Jeune, Vice Chancellor of Oxford.
**Henry G. Liddell*, Dean of Ch. Ch.
**Henry W. Acland*, Regius Professor of Medicine.
John Phillips, Professor of Geology.
B. C. Brodie, Professor of Chemistry.
**William Ward*, Mayor.
C. J. Sadler, Alderman and J. P.
Geo. P. Hester, Town Clerk.
Henry Cowper, Mayor of Banbury.
**F. L. Dashwood*, Kirtlington.
J. Hyde, Mayor, Abingdon.
J. C. Clutterbuck, Vicar of Long Wittenham.
Hugh Pearson, Vicar of Sonning.
Edward Reynolds, Mayor of Wallingford.

App. No. 4.

J. Kirby Hedges, Town Clerk.
Richard Benyon, M.P. for Berks.
Edward Wells, M.D., Physician to the Royal Berks Hospital, Reading, and Member of the Local Board of Health.
Charles Cowan, M.D., Physician to the Royal Berks Hospital.
R. Woodhouse, M.D., Physician to the Royal Berks Hospital.
George May, Consulting Surgeon to the Royal Berks Hospital.
**Charles Henry Hartshorne*, Rural Dean, Rectory of Holdenby.
**William Acworth*, Vicar of Plumstead.
Thos. B. Morrell, Rector of Henley-on-Thames.
W. H. Brakspear, Mayor of Henley-on-Thames.

28 May 1862.

Those whose names are marked thus * formed (with others) the deputation to Sir G. Grey, 3d June 1862.

Appendix, No. 5.

LETTER from Mr. *Rawlinson* to Lord *Robert Montagu*, M.P.

App. No. 5.

Local Government Act Office,
Whitehall, 1 July 1864.

My Lord,

WITH respect to Boards to manage Drainage Areas, I fear any plan of representation embracing even one member from each separate Local Board of Health will not prove to be practicable, on account of numbers. Take, for instance, the Aire and Calder Drainage Area, which is about 800 square miles. There are at present 71 Local Boards of Health, and will be more. Each such Local Board may require to be rated for river improvements, and controlled, with respect to outfall sewage; but a Drainage Area Board, with only 71 members, one from each Board, would be cumbersome for work. There must, however (if representation is to rule the formation of such Boards), be canal, river, land, and mill representatives. I must confess that I do not see the way to purely Local Boards for Drainage or River Areas. The machinery must be in some other form. Rivers require to be improved, and preserved from injury, irrespective of county, parish, township, or private boundaries. Permissive power, will only mean power to do nothing, as at present. Those who abuse will, for the most part, govern; and, as in the case of the Smoke Act, any Act of a similar kind will, like this, be a dead letter. Of what use is a Smoke Act in Manchester, Salford, Wigan, and other manufacturing towns, where the members of the several Corporations are smoke makers? Suppose factory owners had been required to appoint and pay factory inspectors, How much useful inspection would have been done?

I don't like advocating Government interference in river preservation; but don't see my way without it. Any Board, to be useful, must consist of working members, with ample powers to devise and execute works, to purchase and remove mill dams, to embank, to drain, and to prevent all forms of abuse on rivers. A Drainage Area Rate would have to be laid, and collected. Superintendence should be regular, and an annual report ought to be published. Machinery, such as is sketched out, will be difficult to establish.

I have put these remarks down without much order, but they can only serve to direct attention to some of the difficulties.

I have, &c.
(signed) *Robert Rawlinson.*

To the Honourable the
Lord Robert Montagu, M.P.

Appendix, No. 6.

LETTER from Mr. *Rawlinson* to Lord *Robert Montagu*, M.P.

Metropolitan Water Supply.

App. No. 6.

Local Government Act Office,
Whitehall, London,
2 July 1864.

My Lord,

In my evidence before the Committee, I stated that the sewage of a population of about 800,000 persons is passed into the River Thames above the point at which water is abstracted to supply the south-western, west, and north-western portions of the metropolis. The river is also fouled by washings from manured fields, and from roads; by bathing, by drowning, and by other forms of fouling. There is not (so far as I am aware) any check to the abuse and fouling of the water, nor any river police to prevent bathing, washing, or drowning dogs or other animals; nor any river scavenging to remove the putrid floating carcasses of drowned animals after death.

As a first step to an improved water, the ordinary Waterworks Clauses against fouling streams and reservoirs may be put in force. It is only the large volumn of water in the Thames, and occasional floods, which disguises existing abuses. A dry year and epidemic period, will so alarm London, at no distant period, that improvement will be demanded.

A remedy to the evils enumerated, will have to be found; in a compulsory amalgamation of the companies using the Thames or any of its tributaries as a means of water source, as in the case of the gas companies in Paris; or purchase by a municipal government acting for the metropolis, or for the portion affected. Isolated companies, as at present constituted, are not likely to carry out any such works as shall materially add to their capital and reduce dividends.

Improvements in the water supply from the River Thames and Thames drainage area may be made:

By taking spring water at its source, and, also,

By taking the water of tributaries above the line of contamination.

Such works as would be necessary would correspond to the most ancient modes of water supply in the East-catchment reservoirs at spring and stream heads. Conduits of earthenware, contouring the country to some common point, there to be taken in one volume, and pumped as at present; or some considerable portion may have "head" sufficient to gravitate.

The River Thames will not be robbed of one gallon more water, the only difference will be, water will be taken before pollution. Mill and proprietary rights are no doubt involved, and must be paid for; the work would be costly, but I think it is (or soon will be) absolutely necessary. As a water drinker and water rate payer, I can promise that, personally, I will consent to an additional water rental of 25 per cent. if necessary, to have water in my house beyond the suspicion of such abominations and fouling as at present takes place in River Thames water.

A new supply of water to the metropolis from any distant source, as North Wales, I consider out of the question, unless the Government of the day should determine that the metropolis, being the seat of Imperial Government, shall be imperially governed, as was Rome in its greatest day, and as is Paris of the present time.

Few men have had a wider practical experience of local self-government than I have. Since the year 1848 to the present date I have been in repeated contact with municipal corporations, boards of commissioners, local boards, and boards of guardians; and I beg, in the strongest terms, to bear my testimony to the advantages such institutions afford in a free country. There are occasional exhibitions of a "Dogberry" character, but the balance is greatly in favour. In any rule, however, there is generally, at the least, one exception; and in this case the metropolis is an exception. An exception, indeed, in more senses than one. The metropolis is at present an unbound bundle of parish vestries and other forms of parish authorities. With one municipal corporation presiding over a small plot of ground (the city) in the centre of disjointed and antagonistic parish authorities, the Metropolitan Board, it is true, acts for the whole in the case of main sewerage works and some minor matters; but gas, water, pavements, &c., obey many masters, who consider they have independent interest, and act accordingly. The existing state of water supply, gas supply, street management, police, is a blot on our civilization. Water pipes and gas pipes lace and interlace the subsoil, which is foul, by gas escapes, beyond description.

The metropolis requires either consolidated municipal institutions or imperial government over its entire area for water, gas, streets, police, markets, sewerage, scavenging, and not only the land but also the river.

I have, &c.
Robert Rawlinson.

To the Honourable
The Lord Robert Montagu, M.P.

Appendix, No. 7.

REMARKS upon the POLLUTION of RIVERS, by *P. H. Holland*, M.R.C.S., Medical Inspector, Burial Acts Office, 4 Old Palace-yard.

App. No. 7.

IT is certain that in many cases, and probably in most, that the losses caused by allowing refuse matter to enter a river far exceed the expense of preventing such injury to the stream; nevertheless the expense is not incurred, but the losses submitted to, partly because they fall upon many in small amounts to each, while the cost would be borne by one or few, but chiefly because the evil is of gradual growth, and often becomes established before steps for its prevention are taken, and sometimes because it has become a complicated question to decide who ought to bear, or who can legally be compelled to bear, the expenses of the remedy.

In 1859 the late Dr. Southwood Smith and I were instructed to inquire as to the effect upon the public health of certain sewer rivers (for the Sewerage Commissioners); our joint report was published in the second report of the Commissioners of 1861 (1962). The sewer river to which our attention was chiefly directed was the Medlock, and its condition offers a good illustrative example of injury done by manufacturing refuse in streams, and the difficulty of applying a remedy. This river receives, besides the sewage of an imperfectly drained but very large town population, an enormous quantity of manufacturing refuse, especially from numerous dye-works, a great part of which is carried into the Duke of Bridgewater's canal, of which the river is a feeder. It deposits in its still water enormous quantities of black mud, which putrefies, and gives off offensive gases, causing the canal to be a serious nuisance for many miles, depreciating the value of houses and of building land near it to the amount of several thousand pounds annually, and putting the owners of the canal to constant cost and inconvenience for removing the refuse obstructing the passage of boats.

That this great nuisance could be abated no one doubts; nor can it be doubted that if those who suffer loss from its continuance had to pay the costs for its remedy they would be great gainers by the change; but this is not done. The sufferers from the nuisance would very naturally object to pay for keeping a canal clean with which they have no concern except as victims to its stench; the owners of the canal may reasonably urge that it is not their fault that the clean stream originally used as a feeder for the canal, has in the course of time become a common sewer, and a channel for the refuse of dye and print works, &c., and the occupants of the populous district draining into the river may argue that they are not to blame, and ought not to pay because their natural drain happens to be used as a feeder to a canal. Twenty years ago I published a plan for what I still believe to be an effectual and economical remedy of this great nuisance, but because it is not decided at whose cost the nuisance ought to be abated, all the parties continue submitting to injuries and losses from it, out of all proportion to the cost of its removal.

Bradford Beck is another instance of a sewer river polluted by dye and other refuse, being the feeder of a canal, and thereby creating a serious nuisance. Throughout the manufacturing districts (especially in South Lancashire and the West Riding of Yorkshire) it is hard to find a stream of considerable size "unpolluted by dyers' chemistry." Those only who have lived in such districts, after having resided in more favoured regions, can fully appreciate the annoyance and privation of enjoyment which the almost universal pollution of rivers causes. Not merely is the great natural beauty of rivers destroyed, but they may even become means of positive annoyance, and in all cases the pleasure of boating and bathing is diminished, fishing spoiled, and the enjoyment of country walks much lessened — evils of serious magnitude, especially to a population too apt to neglect bodily exercise. The very manufactures, moreover, for the sake of which these evils are submitted to, are probably more impeded than benefited by pollution of natural streams being permitted for their immediate convenience: for example, as is well known, that the finest calico printing requires very pure water, even a slight contamination impairing the beauty of fine colours. To obtain this pure water, great expense is incurred, by establishing printing works in remote and inconvenient situations, near the sources of streams with water unpolluted; but the calico printer, having thus obtained pure water for his own works, effectually damages the stream for all below him, by pouring into it all the waste colouring matter and other refuse he wants to get rid of; and though the quantity of such matter may be small, the quantity of water polluted by it is very great, and the value of the stream is materially impaired for future use. If the pollution of the stream were prevented, its value would remain unimpaired; and though the manufacturer highest on the stream might have to spend something more to avoid injuring those below him, all below would receive great benefit, probably much greater benefit than the cost the one highest on the stream would incur. A great part of this discoloration of water is caused by the washing away of surplus colouring matter, not fixed on the cloth by mordants, and for this washing a very large quantity of water is used, and that being returned to the stream, discolours the whole. If the water thus discoloured were kept apart from the rest of the stream, the discoloration of the whole would be prevented, but the value of the stream would be impaired by its volume being diminished; such diminution of volume would probably be reduced to small amount if the discoloration of natural streams were not permitted, for then manufacturers would extend the plan of washing a succession of pieces of cloth in the same water, and so reduce the quantity of water discoloured to a moderate amount.

As a matter of course, it will be asserted that any change in the process, however good in theory, is in practice impossible. Every proposed improvement is denounced as impracticable until it is tried, but if manufacturers were prevented throwing upon others the inconvenience of their own refuse, they would find modes of diminishing that inconvenience; it is, moreover, exceedingly probable if the pollution of streams were prevented, and attention forced to other plans for disposing of refuse, that profitable uses for the refuse would be discovered and employed, as has been the effect in many instances of preventing refuse matters being simply thrown away; for example, when gas-makers were prevented throwing their refuse into rivers, because it killed the fish, and rendered the water offensive, attention was called how otherwise to dispose of it, and it was soon found that much of it could be turned to use, and now the demand for such waste products is likely to exceed the supply. Again, 20 years ago the waste acid of alkali works was all sent up the chimneys, and did great mischief to neighbouring trees and other vegetation; actions and indictments for nuisances checked this, and manufacturers being compelled to absorb their waste acid, tried to turn it to profit, and have to a great extent succeeded. There are numerous instances where persons have been compelled to abate nuisances, and have afterwards found that it was profitable to do so, though before trying they protested it was impossible to do so, without ruin. The abatement of the smoke nuisance is a familiar instance which has been effected with profit in many cases, and at little cost in any, but would not have been effected unless enforced by law. So will it be with the pollution of water.

A calico printer, at the head of the stream, has no right, for his own profit, to render that stream of less value to every one else, but has little inducement, unless compelled, to incur any trouble or expense to prevent injury, the cost of which would do him little good, but might assist his rivals in trade considerably. The real question to be asked is, can the injury be prevented without seriously impeding the manufacturer. This can only be decided by careful inquiry in each class of case, but it is highly probable that often the injury may be considerably, perhaps almost entirely, prevented.

Sometimes acids or injurious salts are allowed to escape into rivers from manufactories, and often mine-water is so polluted. This may render the stream unfit for cattle, and is often destructive to the fish. It is probable that such injury might be prevented without serious cost by passing such water over chalk, and retaining it in subsidence ponds until clear, or by filtering. The same processes would clear the water of fine particles in suspension, which are sometimes injurious to fish.

In some cases it will be expedient to purify water by the plan proposed by the late Dr. Clarke, of Aberdeen, which would neutralize any acid present, decompose poisonous salts commonly met with, and separate most of the suspended impurities, but not all those in solution. This process has been used with great effect to free the sewage of Leicester (which contains much manufacturing refuse) from its suspended matter. The purified sewage flows quite clear into the river Soar, which used to be dreadfully offensive, but is now clean and well stocked with fish. At Stroud also the water is very considerably, though not so perfectly, freed from serious impurity.

At Birmingham and Coventry, sewage, also containing much manufacturing refuse, is to a great extent purified. Carlisle is the most perfect instance I have seen of the inoffensive disposal of sewage, and there it is stated there has been a large profit, as may be the case at places I have not seen.

Another sort of injury to rivers is produced by throwing into them matters which render the water unnaturally muddy, or which form obstructions to the stream. In the case of the Irwell and Mersey, this has been done to such an extent, that the Trustees of the late Duke of Bridgewater, as owners of the Irwell and Mersey Navigation, applied to Parliament for a special Act of protection, and other navigable rivers have been similarly injured by the same causes. In other cases, streams not navigable have been so obstructed as materially to interfere with drainage.

The Croat at Bolton, the Irwell at Bacup, and the Medlock in Manchester, are examples; such are, however, very numerous.

There does not seem to be any authority with effective power to guard against such evils, which produce great mischief and loss, and would not be very expensive to prevent, at least in many cases. Very often the water from mines flowing into rivers is simply muddy, and would not do harm if freed from mechanical impurities by filtering or subsidence, or by (what would often be more advantageous) making the muddy stream run over and irrigate some grass land on which it would deposit its mud before returning to the river. The mud might do some harm to the grass if deposited too thickly, but that would be a trifling evil compared with that now inflicted by spoiling the stream.

Often, however, mine water contains chemical impurity, the most common of which is sulphate of iron, with excess of sulphuric acid, arising from decomposed pyrites, mundic, and other sulphurets. Sometimes sulphuretted hydrogen is dissolved in mine water, and occasionally metallic salts are either dissolved or minutely suspended in it in sufficient quantity to be injurious to fish, or to cattle which drink of the streams. Mine water, containing excess of sulphuric acid, if used for steam engines, destroys the boilers, and is thus a source of serious danger. A complete economical remedy for all these mischiefs is not known, but it would not be difficult to devise methods not too expensive to be practicable, for diminishing the evils, and it is not improbable that great improvements in these methods would be introduced if attention were strongly directed to them.

I feel very confident of its being possible to reduce the evils to a very small amount, at less cost than the endurance of them entails, but it unfortunately happens that those who would have to bear the cost of the remedy are not always or generally the same persons who suffer losses and inconveniences from the pollution of the streams.

If, however, the streams were placed under an effective conservancy, such authority having power effectually to prevent any stream from being unfairly injured, those who now, from idleness, carelessness, or love of saving their own money, even at greater cost to others, would be compelled to study how to carry on their business without injury to others; and experience in other analogous cases shows there is great probability of such injuries being preventible with little trouble or expense, at least with little compared with the injury to be prevented.

Appendix, No. 8.

PAPER put in by Mr. *Ferrand*, M.P.

Cullingworth Mills, near Bingley,
Dear Sir, Yorkshire, 14 June 1864.

I HAVE to acknowledge receipt of your letter of yesterday.

With reference to any evidence I might be able to give before the Metropolitan Sewage Committee, I hardly think it would be worth while the expense to the Committee, and the inconvenience of leaving home at present.

The main feature of the principle we have adopted for the filtration of the dye and soapy waters from our works is, the passing those waters through a bed 15 to 20 feet thick of engine ashes, leaving the solid matters as a crust at the bottom of the tanks, formed of engine ashes; the crust, of course, having to be taken from inside the bottom of the tanks regularly at stated periods, say twice or three times per month. This crust makes excellent manure, and we spread it, at once, on grass or arable land.

With especial reference to the soapsuds, they go from our wool washhouse into tanks very strongly made, and lined with double bricks, walled in cement.

The suds are then boiled in these tanks and broken with acid; the magma, or thick creamy part, rises to the top. The thin watery part below is run off into the engine ashes filters, percolating through them into the beck, and thus escapes in quite a clear state.

The thick part left in the brick tanks is then run into filters made of cocoanut matting, lined with canvas, and when of the consistency of, say, cream cheese, is wrapped in canvas bags, to be pressed in steam presses, whereby the grease is pressed out, of which we make about 30 cwt. per week, besides a large quantity of solid manure, in the form of oilcake, which is periodically taken on to the land, and makes very excellent manure.

This system of purification is readily done in moderate-sized works; but in such immense affairs as a Metropolitan Works Company, it would, of course, require great outlay.

I may just say that the grease we extract from the soapsuds, is now worth 17 *l.* per ton, and is sold to candle and soap manufacturers. If there is any other information I can give you, I shall be most happy to do so, and render any little service I am able.

I remain, &c.
Edward Townend.

Wm. Ferrand, Esq., M.P.

Appendix, No. 9.

PAPER put in by Mr. *Gael*, 9 June 1864.

SEWER CHART.—TOWER HAMLETS (excepting St. Katherine's)

STATUTES:—Aa. Statutes 23 H. 8, c. 5 & 19; Ab. 3 & 4 Edw. 6, c. ; Ac. 13 Eliz. c. 9; Ad. 7 Anne, c. 10; Ba. Jac. 1. c. ; Bb. 2 W. & M., Sess. 2

	SUBSTANTIAL AND INDIFFERENT PERSONS			
	Their Qualification.	Charge.	Continuance.	Sanctions.
FUNCTIONARIES.	*Qualification.*—1. By land, having lands in fee or for life, of 40 marks value yearly [26 *l.* 13 *s.* 4 *d.*] 2. By citizenship and personals, being resident in and free of any city or borough, and having 100 *l.* 3. By erudition, being barrister of one of the four Inns of Court. *Disqualification.*—Being a farmer [lessee] for years of tenements chargeable under the Commission, who has not 40 *l.* a-year freehold estate, but he may sit and establish ordinances concerning all lands but his own, Ac. ss 4, 7.	Commissioners authority— Partly, 1. Judiciary in decreeing on presentments of jury; and Partly, 2. Administrative in acting on their own survey. Commissioners to give diligent attendance on the Commission, Aa. 5. To exercise their discretion according to law. Oath of faithful execution taken before Sessions, or under writ of Dedimus Potestatem, A.	Commission continues for 10 years, and is determinable by demise of the Crown. Also, it is determined by writ of Supersedeas out of Chancery, Aa.	Commissioners sitting without qualification, 40 *l.* for every sitting, half to the informer. Five marks for refusing to take the oath when required by writ, but no person compellable to act unless he be resident in same county, 25 H. 8. c. 10, ss. 1, 2. Sitting unsworn, like penalty as when not qualified, Aa.

	ORDINANCES.	SURVEYS.	IMPEDIMENTS.
ADMINISTRATIVE WORKS,	Commissioners may make and ordain, alter and repeal statutes, ordinances, and provisions for safeguard, redress, and correction. To be written in duplicate on parchment indented, and under seal of six of the Commissioners, one part deposited with clerk, and other where Commissioners direct, and then they continue, notwithstanding the Commission is superseded, Ac. s. 1.	Commissioners to make surveys at certain times and places, of ditches, sewers, and trenches, so that no hurt or peril shall happen, Aa. s. 3.	Mills, mill-dams, flood-gates, ponds, locks, hebbing weirs, and other lets and impediments, interrupting the passage of water. 1. To survey. 2. To reform, amend, prostrate, and overthrow when found by inquest or by survey, and discretion of the Commissioners, to be excessive or hurtful, Aa. s. 3.

	PROPERTY.	CHARGES.	RATE.		
			Upon what.	Upon whom.	How made.
TRUST.		Persons found by inquisition to be in default, are chargeable with the costs of repairs of their damages, Aa.	Lands, tenements, rents, common of pasture, profit of fishing, commodities.	Persons who hold such property, or may have loss, Aa. ss. 3, 7. Corporations are liable in respect of their possessions.	Jury to present parties liable. Court of Sewers to tax them according to the quantity of their lands, and the rate of every person's portion, tenure, or profit, A. ss. 3, 7. Commissioners may assign surveyors, Aa. s. 13.

	COMMISSIONERS MEETING OR COURT.	JUDICIARY POWER OF COMMISSIONERS.		
		Process.	Presentment of Jury.	Trial and Determination.
PROCEDURE.	Six Commissioners make a court, or meeting, three being of the quorum, Aa. The Commissioners have a Court of Record.	Parties may complain before Commissioners.	Commissioners to inquire by Jury,— 1st. Through whose defaults, hurts and damages have happened [for purpose of punishment]. 2nd. And who have lands, or may have loss or disadvantage by any means, as well in places, where are the dangers as thereabouts [for purpose of taxation].	Presentment may be traversed. Commissioners to try traverse or decree on presentments. To hear and determine the plaints of parties. What is done by survey, cannot be traversed, nor fines for contempt. Commissioners to fine and amerce.

Appendix, No. 9.

PAPER put in by Mr. *Gael*, 9 June 1864.

SEWER CHART.—TOWER HAMLETS (excepting St. Katherine's).

c. 8, s. 12.——DISTRICT :—Limits named in the Commission. The limits of the Tower Hamlets, excluding St. Katherine's and Blackwall Marsh.

NAMED AS COMMISSIONERS AND JUSTICES.

Privileges.	Ministers.	Officers.	Purveyance.	Contracts.
Commissioners to have 4*s.* a day for every day they take pains in executing the Commission, Aa.	Commissioners to direct writs to sheriffs and bailiffs. Sheriff to return a jury of the shire or place where defaults and annoyances be. All other ministers to be attendant on the Commissioners.	Commissioners may depute and assign officers and ministers for the conservation and reformation of sewers. Clerk. Collectors. Expenditors. Surveyors. Keepers and bailiff.	Commissioners may arrest labourers, and take carriages, timber, and necessaries, paying competent wages, &c., Aa. s. 3.	

SEWERS AND WORKS GENERALLY.	NEW SEWERS.	PRIVATE DRAINS.	NUISANCES.	WAY LEAVES	
				Streets.	Lands.
Walls, streams, ditches, gutters, banks, sewers, gates, calcies, bridges, being defences of marsh ground and trenches of fresh water. 1. To survey. 2. To reform. 3. As often as need be to make new trenches, sewers, and ditches in all places necessary to cleanse and purge, Aa. Sewers and watercourses within the limits of two miles of the City of London, coursing into the Thames, to survey reform, Ba. Sewers made under the London and Westminster Paving Act, 13 & 14 Chas. c. 2, to alter, amend, cleanse, &c., Bb. s. 14.	In parts within the meaning of Bb. [St. 12 W. & M., Sess. 2, c. 8], to make new vaults and sewers. *Ibid.* s. 14.				

RATE.		MONEY BORROWING.	EXPENDITURE.	ACCOUNTS.
Correction.	Recovery.			
Appeal to the Court of Sewers. Certiorari to remove the order for a rule into B. R. Replevin and trespass for illegal rate.	By distress, Aa. ss. 3. 7; Ad. s. 3, property of Crown liable. By decree and sale of land (copyhold, as well as freehold, Ad.) by their sealed indenture on parchment, Ac.		Clerk to estreat amerciaments and fines into the Exchequer yearly, Ac. s. 1, to be transmitted to Treasury and Audit Office, on oath before justice of peace, 3 & 4 W. 4 c. 99, ss. 29, 30.	Collectors and other ministers to account to the Commissioners for monies levied and expended. The Commissioners to hear the account of the collectors and other ministers appointed by the Commissioners, Aa. ss. 3, 7.

JUDICIARY POWER OF COMMISSIONERS.		GENERAL LAW PROCEDURE.
Execution.	Review.	
Decree of taxation, bonds, lands, and goods, Aa. s. 3; Ad. Commissioners' warrant to levy fines and amerciaments.	Decree may be removed by certiorari into B. R. Action lies against Commissioners and their officers for illegal acts.	In action of trespass, or other suit brought against anyone for taking distress, or doing any other Act under the Commission, or statutes, the defendant may make avoury cognizance or justification, alleging the authority of the Commission, without special pleading, replication, issue thereon, trial by jury. If verdict for defendant, treble damages, and his costs, Aa. s. 12.

Appendix, No. 10.

SEWAGE (METROPOLITAN, &c.).

PAPER put in by Mr. *Bateman*, 6 June 1864.

TABLE, showing the Discharge in Gallons per Day (of 24 Hours) of Pipes or Conduits of different Diameters, and with the various Slopes, as deduced from the Formula of *Du Buat.*

Diam. in Feet.	3 Feet per Mile. 1 in 1,760.	4 Feet per Mile. 1 in 1,320.	5 Feet per Mile. 1 in 1,056.	Diam. in Feet.	6 Feet per Mile. 1 in 880.	7 Feet per Mile. 1 in 754.	8 Feet per Mile. 1 in 660.
·25	13,166	15,783	17,422	·25	19,220	20,938	22,577
·50	77,370	89,946	102,420	·50	112,780	123,030	132,540
·75	216,780	251,980	286,470	·75	315,970	347,390	371,420
1	449,100	522,280	593,750	1	655,480	680,010	770,510
1¼	789,110	917,810	1,043,400	1¼	1,151,100	1,255,500	1,322,500
1½	1,251,200	1,455,500	1,655,600	1½	1,825,000	1,989,600	2,143,800
2	2,567,500	3,005,900	3,417,000	2	3,770,500	4,112,200	4,131,900
2½	4,698,700	5,275,600	5,999,700	2½	6,615,700	7,215,600	7,775,900
3	7,373,000	8,351,000	9,492,100	3	10,470,000	11,418,000	12,305,000
3⅓	9,356,600	11,393,000	12,398,000	3⅓	13,679,000	14,927,000	16,076,000
3½	10,879,000	12,312,000	14,013,000	3½	15,505,000	16,863,000	18,168,000
3⅔	11,900,000	13,840,000	15,727,000	3⅔	17,353,000	18,922,000	20,389,000
4	14,811,000	17,302,000	19,616,000	4	21,653,000	23,516,000	25,380,000
4½	19,910,000	23,147,000	26,307,000	4½	29,029,000	31,658,000	34,116,000
5	25,955,000	30,174,000	34,286,000	5	37,849,000	41,274,000	44,478,000
6	37,372,000	43,445,000	49,412,000	6	56,019,000	59,429,000	64,042,000
8	84,328,000	98,066,000	111,470,000	8	122,980,000	133,800,000	144,570,000
10	147,590,000	172,040,000	195,500,000	10	215,710,000	235,300,000	253,520,000

Diam. in Feet.	9 Feet per Mile. 1 in 587.	10 Feet per Mile. 1 in 528.	12 Feet per Mile. 1 in 440.	Diam. in Feet.	14 Feet per Mile. 1 in 377.	16 Feet per Mile. 1 in 330.	20 Feet per Mile. 1 in 264.
·25	24,111	26,187	28,367	·25	30,958	33,444	37,779
·50	141,530	150,300	166,690	·50	181,690	196,280	221,860
·75	396,400	421,150	466,830	·75	509,170	549,860	621,720
1	822,940	873,700	968,420	1	1,056,400	1,140,600	1,289,400
1¼	1,445,200	1,532,900	1,701,500	1¼	1,855,400	2,003,500	2,265,200
1½	2,291,200	2,431,100	2,695,600	1½	2,940,100	3,175,200	3,590,000
2	4,734,700	5,023,900	5,570,400	2	6,076,100	6,563,300	7,417,400
2½	8,307,200	8,817,500	9,951,000	2½	10,662,000	11,514,000	13,020,000
3	13,146,000	13,987,000	15,507,000	3	16,872,000	18,223,000	20,602,000
3⅓	17,173,000	18,233,000	19,744,000	3⅓	22,042,000	23,808,000	26,916,000
3½	19,427,000	20,654,000	22,840,000	3½	24,917,000	26,907,000	30,419,000
3⅔	21,783,000	23,130,000	25,637,000	3⅔	27,963,000	30,199,000	34,138,000
4	27,112,000	28,777,000	31,910,000	4	34,799,000	37,580,000	42,492,000
4½	36,436,000	38,681,000	42,885,000	4½	46,773,000	50,514,000	58,453,000
5	47,512,000	50,429,000	55,885,000	5	60,980,000	65,865,000	74,460,000
6	68,411,000	72,611,000	80,360,000	6	87,802,000	94,820,000	107,200,000
8	154,390,000	164,150,000	181,710,000	8	198,180,000	216,270,000	305,440,000
10	270,860,000	288,150,000	318,780,000	10	345,270,000	372,860,000	421,540,000

Appendix, No. 11.

PAPERS put in by Mr. *Bateman*, 9 June 1864.

App. No. 11.

COST of BRICK CULVERTS as compared with cost of CAST IRON PIPES.

Diameter 2 feet, thickness of brickwork 4½ inches.
·311 cubic yards in a yard forward.
547·5 cubic yards in one mile.
3,090 cubic yards of excavation in one mile.

Diameter 3 feet, thickness of brickwork 9 inches.
·981 cubic yards in a yard forward.
1,726·5 cubic yards in one mile.
6,600 cubic yards of excavation in one mile.

Diameter 4 feet, thickness of brickwork 9 inches.
1·246 cubic yards in a yard forward.
2,193 cubic yards in one mile.
9,142 cubic yards of excavation in one mile.

Diameter 5 feet, thickness of brickwork, sides 1′, 2″, top and bottom 9″.
2·113 cubic yards in a yard forward.
3,719 cubic yards in one mile.
13,470 cubic yards of excavation in one mile.

COST PER MILE.

Diameter of Sewer.	Brickwork at 15 *s.* per cubic yard.	Brickwork at 20 *s.* per cubic yard.	Brickwork at 25 *s.* per cubic yard.	Excavation at 1 *s.* 6 *d.* per cubic yard.	TOTAL cost at 15 *s.* per cubic yard.	TOTAL cost at 20 *s.* per cubic yard.	TOTAL cost at 25 *s.* per cubic yard.	TOTAL cost of Cast Iron Pipe at £. 5.	TOTAL cost of Cast Iron Pipe at £. 6.
Feet.	£.	£.	£.	£.	£.	£.	£.	£.	£.
2	410	547	684	232	642	779	916	3,092	3,552
3	1,295	1,726	2,157	495	1,790	2,221	2,652	5,676	6,583
4	1,645	2,193	2,741	685	2,330	2,878	3,426	9,267	10,769
5	2,789	3,719	4,649	1,010	3,799	4,729	5,659	13,885	16,134

App. No. 11.

COST of Cast Iron Pipes, including Laying and Jointing.

Diameter of the Pipe in Feet.	Pressure.	Thickness.	Weight per Lineal Yard.			Weight per Mile.	Cost per Mile at £. 5 per Ton.	Laying and Jointing.	TOTAL.	Cost per Mile at £. 6 per Ton.	Laying and Jointing.	TOTAL.
	Feet.		cwt.	qrs.	lbs.	Tons.	£.	£.	£.	£.	£.	£.
2	100	¾	5	1	3	460	2,300	792	3,092	2,760	792	3,552
"	200	⅞	6	0	21	544¼	2,721	792	3,513	3,265	792	4,057
"	300	1	7	0	12	625½	3,127	792	3,919	3,753	792	4,545
"	400	1⅛	8	0	4	707	3,535	792	4,327	4,242	792	5,034
3	100	1	10	1	13	906½	4,532	1,144	5,676	5,439	1,144	6,583
"	200	1⅛	11	1	25	1,010	5,050	1,144	6,194	6,060	1,144	7,204
"	300	1⅜	13	3	14	1,221	6,105	1,144	7,249	7,326	1,144	8,470
"	400	1¾	17	2	13	1,590¾	7,953	1,144	9,097	9,544	1,144	10,688
4	100	1¼	18	0	23	1,501½	7,507	1,760	9,267	9,009	1,760	10,769
"	200	1½	21	0	24	1,888½	9,442	1,760	11,202	11,331	1,760	13,090
"	300	1¾	25	0	11	2,295½	11,492	1,760	13,252	13,791	1,760	15,551
"	400	2⅛	31	0	7	2,733¼	13,666	1,760	15,426	16,400	1,760	18,160
5	100	1½	25	2	6	2,249	11,245	2,640	13,885	13,494	2,640	16,134
"	200	2	34	1	12	3,023½	15,117	2,640	17,757	18,141	2,640	20,781
"	300	2¼	38	3	0	3,410	17,050	2,640	19,690	20,460	2,640	23,100
"	400	2½	43	1	5	3,810	19,050	2,640	21,690	22,860	2,640	25,500

The pressures given in this Table are those which the pipe is supposed to have to bear in actual work. Each pipe should be proved to double this pressure before being laid.

Appendix, No. 12.

PAPER put in by Mr. *Bateman*.

App. No. 12.

GLASGOW CORPORATION WATERWORKS.

CITY PIPING.

EXTRACTS from Specification of Cast Iron Pipes supplied to the *Glasgow* Waterworks Commissioners, 1858.

SCHEDULE.

Diameter of Pipe.	Length of each Pipe.		Thickness of Metal.	Depth of Socket.	Mean Weight of each Pipe.			Permitted Deviation in Weight.	Proof Pressure equal to a Column of Water.	Or lbs. per Square Inch.	Maximum Pressure, in Feet, to which Pipes will be subject in Work.
Inches.	*Ft.*	*Ins.*	*Ins.*	*Ins.*	*Cwt.*	*qrs.*	*lbs.*		*ft. in height*		
33	12	5	1	5	39	1	25	2 per cent.	400	173	210
30	12	5	$1\frac{1}{4}$	5	44	–	3	,,	600	260	300
,,	12	5	1	5	35	3	5	,,	500	217	230
24	12	5	1	5	28	1	23	,,	600	260	300
20	9	$4\frac{1}{2}$	$\frac{7}{8}$	$4\frac{1}{2}$	16	–	4	,,	500	217	270
,,	9	$4\frac{1}{2}$	$\frac{3}{4}$	$4\frac{1}{2}$	13	3	25	,,	450	195	240
18	9	$4\frac{1}{2}$	$\frac{13}{16}$	$4\frac{1}{2}$	13	1	12	$2\frac{1}{2}$,,	600	260	300
,,	9	$4\frac{1}{2}$	$\frac{3}{4}$	$4\frac{1}{2}$	12	1	19	,,	500	217	260
,,	9	$4\frac{1}{2}$	$\frac{11}{16}$	$4\frac{1}{2}$	11	1	27	,,	450	195	230
16	9	$4\frac{1}{2}$	$\frac{3}{4}$	$4\frac{1}{2}$	10	3	27	,,	600	260	300
,,	9	$4\frac{1}{2}$	$\frac{11}{16}$	$4\frac{1}{2}$	10	–	18	,,	500	217	250
,,	9	$4\frac{1}{2}$	$\frac{5}{8}$	$4\frac{1}{2}$	9	1	9	,,	400	173	200
15	9	$4\frac{1}{2}$	$\frac{11}{16}$	$4\frac{1}{2}$	9	2	3	,,	500	217	270
,,	9	$4\frac{1}{2}$	$\frac{9}{16}$	$4\frac{1}{2}$	7	3	25	,,	400	173	180
14	9	$4\frac{1}{2}$	$\frac{11}{16}$	$4\frac{1}{2}$	8	3	23	,,	600	260	290
,,	9	$4\frac{1}{2}$	$\frac{5}{8}$	$4\frac{1}{2}$	8	–	25	,,	500	217	250
,,	9	$4\frac{1}{2}$	$\frac{9}{16}$	$4\frac{1}{2}$	7	2	–	,,	400	173	200
12	9	$4\frac{1}{4}$	$\frac{5}{8}$	$4\frac{1}{4}$	6	3	13	3 ,,	600	260	290
,,	9	$4\frac{1}{4}$	$\frac{9}{16}$	$4\frac{1}{4}$	6	–	26	,,	500	217	240
10	9	4	$\frac{9}{16}$	4	5	–	16	,,	600	260	300
9	9	4	$\frac{9}{16}$	4	4	2	24	,,	600	260	300
8	9	4	$\frac{1}{2}$	4	3	2	23	,,	600	260	300
7	9	$3\frac{1}{2}$	$\frac{1}{2}$	$3\frac{1}{2}$	3	1	1	4 ,,	600	260	300
6	9	$3\frac{1}{2}$	$\frac{7}{16}$	$3\frac{1}{2}$	2	1	27	,,	600	260	300
5	9	$3\frac{1}{2}$	$\frac{13}{32}$	$3\frac{1}{2}$	1	3	24	,,	600	260	300
4	9	3	$\frac{3}{8}$	3	1	1	20	,,	600	260	300
3	9	3	$\frac{3}{8}$	3	1	–	10	,,	600	260	300
2	6	3	$\frac{3}{8}$	3	–	2	4	,,	600	260	300

All pipes above 12 inches in diameter to have wide sockets for lead joints; those of 12 inches and lesser diameter to have, principally, turned and bored joints—from 5 to 20 per cent. of each size, according to circumstances, having wide sockets. All pipes with wide sockets above four inches in diameter to have three-eighths of an inch for the joint; the pipes of four, three, and two inches in diameter to have one-fourth of an inch for the joint.

The whole of the pipes to be subject to proof by hydrostatic pressure according to the foregoing Schedule.

Each pipe, while the pressure is upon it, must be rapped with a hand-hammer from end to end, so as to discover whether there are any sandy, porous, or blown places; the hammer to vary from 4lbs. to 7lbs in weight, according to the size and strength of the casting.

The whole of the pipes to be cast vertically in dry sand-moulds, and to be of uniform bore and uniform thickness of metal throughout, without any belts; the whole to be of the best grey metal, remelted from the cupola, and to be perfectly free from flaws and defects of every kind.

All pipes of 18-inches diameter and upwards to be cast with the sockets downwards; those below that size may be cast with the sockets upwards.

All pipes to be carefully coated inside and out with coal-pitch and oil, according to Dr. R. A. Smith's patent process. The coating to be applied at a proper heat, and in a proper manner, before any rust sets in, and the operation to be performed under the inspection of a person to be appointed and paid by the Commissioners.

Appendix, No. 13.

PAPER handed in by Mr. *West*, to show the WORK performed by CORNISH ENGINES.—May 1858.

_ The Horse Power of Engines in this Report is made up on the following Scale:

SINGLE ENGINES.—	60-inch cylinder and above,	load 15 lbs. per square inch on the piston,	actual velocity 220 feet per minute,	effective velocity 110 feet per minute.
„	45-inch to 60-inch cylinder,	load 16 lbs. „ „	„ 220 feet „	„ 110 feet „
„	30-inch to 45-inch „	load 17 lbs. „ „	„ 220 feet „	„ 110 feet „
„	under 30-inch „	load 18 lbs. „ „	„ 220 feet „	„ 110 feet „
DOUBLE ENGINES	- - - - -	load 10 lbs. „ „	„ 250 feet „	„ 250 feet „
COMBINED PUMPING ENGINES	- - -	load 15 lbs. per sq. inch on the large piston	„ 220 feet „	„ 110 feet „
COMBINED ROTARY ENGINES	- - -	load 7½ lbs. „ on each piston -	„ 250 feet „	„ 250 feet „

The horse-power is taken at 33,000 lbs., lifted one foot high, and the actual horse-power employed, &c. at this rate per minute. The length of the Lifts is given without any allowance for head water; but to all Forcing Plunger Lifts one-half the length of the stroke in the pump is added in making up the duty. No allowance is made for Dry Rods in shafts, Horizontal Rods, or any other matters, without being specified in the remarks.

Where the Steam-pipes and Boilers are left uncovered for the purpose of drying the men's clothes, the following deductions are made from the actual consumption of coals:—

Engines working under 2 strokes per minute	- - - - 1-7th.	Engines working 3, and under 5 strokes per minute	- - - - 1-9th.
„ „ 2, and under 3 strokes	- - - - 1-8th.	„ above 5 strokes	- - - - - - - 1-10th.

The variation in the quality of coal, even from the same pit, is great; and the economy in attending to this will be found to vary from one-twelfth to one-fifth of the consumption. This presents ample inducement for purchasing the best coals, and thus securing more regular and greater duty from the engines.

All engines upon the same principle, with due proportions in their construction, must possess proportionate power; but it has long been the practice to vary the load with some reference to the size, and it is upon this GENERAL PRACTICE that this scale of power is introduced.

All Whim Engines drawing with one kibble only have one-third part of the weight they draw added in the duty, for the extra weight of the kibble and chain.

The Combined Engines are estimated upon a scale to which the united consent of several eminent Engineers has been given, as the result of their experience, with this difference, that one of them considers the Rotative ought to be calculated at 10 lbs. per inch upon each piston, and not 7½ lbs., as above. There are however others, of the first respectability in their profession, that differ from this scale, but they have not furnished us with their views.

William Browne.

NOTE.—P signifies Forcing Plunger Lift, and D Drawing Lift.

PUMPING ENGINES.

MINES AND PERIOD.	Engines and their Power.	When made, Maker's Name, and from what Engineer's Drawings.	Stroke in Cylinder and Pump.	Number and Description of Lifts, and Diameter of Column.	Length of Lifts.	Square Inches in Water-way of Clacks.	Load in Pounds.	Load per Square Inch on the Piston.	Number of Strokes.	Number of Strokes per Minute.	Gallons of Water drawn per Minute.	Cwts. of Coals Consumed.	Millions Lifted 1 ft. high by Consuming 1 cwt. of Coals.	Actual Horse-power Employed.	Hourly Consumption of Coals per Horse-power.	Oil and Tallow Consumed.	GENERAL REMARKS, AND SUPERINTENDING ENGINEER'S NAME.
			Ft. in.	*In.* *In.*	*Fms. ft.*			*Lbs.*					*Lbs.*		*Lbs.*		
BOSCUNDLE -	Matthew's 32 inches single, 46-horse.	1835. Sandys & Co. Sims.	9 0 7 0	1 - 9 P - 10 1 - 11 P - 10 2 - 6 D - 7	20 0 48 3 31 1	–	17,852	17·3	–	–	–	–	–	–	–	qts. lbs.	Drawing perpendicularly. Main beam over the cylinder. One balance bob. *W. West.* Boiler and steam-pipes' partly uncovered, and one-twentieth of the coals allowed.
CARVATH UNITED MINES	38 inches single, 64-horse.	1852. West & Sons. W. West.	8 3 7 9	1 - 8 P - 12 1 - 11 P - 12 1 - 8½D - 9	22 5 29 2 10 1	144 144 81	12,011	–	–	–	–	–	–	–	–	–	Drawing perpendicularly. Main beam over the cylinder. One balance bob at surface. One boiler, 12 tons. *W. West.*

DEVON GREAT CONSOLS.	Morris's 40 inches single, 71-horse.	1845. Perran Foundry Co. W. West.	9	0	1 - 10 P - 11	40	0	53	44,150	24·5	–	–	–	–	–	–	–	qts. lbs.	Drawing from three shafts, 373 fms., horizontal rods, 4 balance bobs, 3 angular bobs at the surface, and 3 underground. Two boilers, 24 tons. *Matthews.*
					1 - 7½ P - 9½	20	0	53											
					1 - 9½ P - 10	33	0	53											
					2 - 9 P - 10	48	0	53											
			7	0	1 - 9 P - 8	29	3	53											
					1 - 8 D - 9	10	0	53											
					1 - 8 D - 9	10	3	53											
			4	0	2 - 8 P - 9	65	0	53											
					1 - 9 D - 8	14	0	53											
	Whl. Emma, 40 inches single, 71-horse.	1846. Perran Foundry Co. W. West.	9	0	1 - 11 P - 12	30	0	53	8,637	6·1	–	–	–	–	–	–	–	qts. lbs.	Drawing perpendicularly. Main beam over the cylinder. One boiler, 11 tons. *Matthews.*
			8	0	1 - 8 D - 9	8	0												
FOWEY CONSOLS. 21 May to 23 June.	Austin's 80 inches single, 251-horse.	1832. Harvey & Co. W. West.	10	4	3 - 15 P - 15	97	3	115	76,525	13·8	256,000	5·4	383	2,264	80·0	115·8	2·8	28 qts. 336 lbs.	Drawing perpendicularly. Main beam over the cylinder, 2 balance bobs at the surface, and 1 underground, working an air machine 24 inches square. Four boilers, 54 tons. *W. West.*
					1 - 13½ P - 13	41	3	273											
			9	3	1 - 12 P - 13	32	0	79											
					1 - 12 P - 13	12	0	79											
GREAT POLGOOTH.	Darlington, 80 inches single, 251-horse.	1834. Sandys & Co. Eustice.	10	0	3 - 19 P - 20	92	5	240	107,354	17·7	–	–	–	–	–	–	–	qts. lbs.	Drawing perpendicularly. Main beam over the cylinder, 1 balance bob at the surface, and 1 at the 36 fms. level. Four boilers, 48 tons. *W. West.* Part of two boilers uncovered for drying men's clothes, and one-twentieth allowed.
					1 - 17 D - 18	22	0	240											
			8	3	1 - 15 D - 16	11	0	195											
					1 - 15 D - 16	16	4	195											
					1 - 11 P - 16	46	1	195											
	Tom Bell, 67 inches single, 176-horse.	1824. Harvey & Co. Sims.	10	0	1 - 10 P - 11	44	5	195	56,816	11·7	–	–	–	–	–	–	–	qts. lbs.	Drawing perpendicularly from two shafts. Main beam over the cylinder, 160 fms. of flat rods, 3 balance and 1 angular bob. Two boilers, 24 tons. *W. West.*
					2 - 14 P - 14	79	4	177											
					1 - 10 D - 11	20	3	170											
			7	6	1 - 10 D - 11	20	3	170											
			6	0	1 - 11 D - 12	13	0												
					1 - 11 D - 12	10	0												
					1 - 7 D - 9	10	0												
LEWIS MINES -	33 inches single, 48-horse.	1845. Sandys & Co. J. West.	10	0	1 - 12 P - 10	48	0	133	25,387	26·7	–	–	–	–	–	–	–	qts. lbs.	Drawing perpendicularly. Main beam over the cylinder, balance on main beam. One boiler, 8 tons. *J. West.* Boiler and steam pipes uncovered.
					1 - 10 P - 9	30	0	79											
			9	0	1 - 10½ D - 11	12	0	38											
					1 - 6 D - 7	4	0	24											
					1 - 9 D - 10	10	3												
MARY ANN - 10 May to 18 June.	46 inches single, 89-horse.	1847. Harvey & Co. W. West.	7	0	1 - 10 P - 11	37	2	33	23,881	14·4	313,000	5·6	134	1,270	41·2	28·4	5·4	qts. lbs.	Drawing perpendicularly. Main beam under the cylinder, 1 balance bob at surface, and 1 at the 50 fms. level. Two boilers, 21 tons. *W. West.*
					1 - 10 P - 10	35	3	33											
			7	0	1 - 10½ P - 9	31	0	33											
					1 - 8½ D - 9	11	0	33											

0.85.

O O

PUMPING ENGINES—*continued.*

MINES AND PERIOD.	Engines and their Power.	When made, Maker's Name, and from what Engineer's Drawings.	Stroke in Cylinder and Pump.	Number and Description of Lifts, and Diameter of Column.	Length of Lifts.	Square Inches in Water-way of Clacks.	Load in Pounds.	Load per Square Inch on the Piston.	Number of Strokes.	Number of Strokes per Minute.	Gallons of Water drawn per Minute.	Cwts. of Coals Consumed.	Millions Lifted 1 ft. high by Consuming 1 cwt. of Coal.	Actual Horse-power Employed.	Hourly Consumption of Coals per Horse-power.	Oil and Tallow Consumed.	GENERAL REMARKS, AND SUPERINTENDING ENGINEER'S NAME.
			Ft. in.	*In.* *In.*	*Fms. ft.*			*Lbs.*					*Lbs.*		*Lbs.*		
PAR CONSOLS	Treffry's 80 inches single, 251-horse.	1846. Harvey & Co. W. West.	12 0	3 - 15¼P - 14	105 3	211	96,730	16·0	253,000	5·3	420	2,877	84·7	154·6	2·6	20 qts. 200 lbs.	Drawing perpendicularly. Main beam over the cylinder, 2 balance and 1 angular bob at surface, connecting 220 fms. of horizontal rods, and 130 fms. of 7-in. dry rods in the shaft. Working one 18-in. pole, 25 fm. 2 ft. as balance only; and one 22-in. air machine at the 80 fm. level. Four boilers, 48 tons. *W. West.* Boilers leaky, and undergoing repair.
				1 - 15¼P - 17	30 5	211											
				1 15 D - 15	3 3	148											
				1 - 15¼D - 16	10 3	211											
			10 0	1 - 12 P - 11	30 2	75											
				11 - 1½D - 12	16 2	75											
				2 - 10 D - 11	27 1	75											
				1 - 10 D - 11	11 5	75											
			8 0	1 - 8 P - 10	16 0	47											
	Puckey's North, 80 inches single, 251-horse.	Sandys - -	9 0	1 - 10 D - 12	22 0	–	9,164	1·6	–	–	–	–	–	–	–	qts. lbs.	Drawing perpendicularly. Main beam over the cylinder. Two boilers, tons. *W. West.*
			8 0	1 - 10 D - 11	10 0												
				1 - 8 D - 9	20 0												
21 May to 23 June.	Puckey's 72 inches single, 204-horse.	1844. Harvey & Co. W. West.	9 3	1 - 8 P - 8	18 2	47	53,009	13·0	124,000	2·6	161	1,129	53·9	38·6	4·1	8 qts. 80 lbs.	Direct acting engine, drawing perpendicularly. Cylinder over the shaft, 2 balance bobs, and one 20-in. air machine at the 80 fm. level. Two boilers, 20 tons. *W. West.*
				2 - 14 P - 15	72 5	129											
				1 - 14 D - 16	10 4	85											
			9 3	1 - 15 D - 18	10 4	129											
				1 - 14¾D - 15	12 5	129											
				1 - 12 D - 13	10 4	129											
				1 - 8 D - 10	10 4	75											
PEMBROKE AND EAST CRINNIS.	80 inches single, 251-horse.	1851. Perran Foundry Co. W. West.	10 6	1 - 10 P - 10	17 0	87	90,510	18·0	184,000	3·9	453	2,152	80·2	112·3	2·7	4 qts. 182 lbs.	Drawing perpendicularly. Main beam over the cylinder, 1 balance bob at surface, with 35 fms. plunger lift, of 20⅛ in. as balance. Four boilers, 48 tons. *W. West.*
				1 - 18 P - 17	41 2	201											
			10 6	1 - 18 P - 19	29 4	240											
				1 - 17 P - 17	30 3	229											
				1 - 14¼P - 15	33 1	229											
				1 - 12 D - 13	14 4	104											
				1 - 10 D - 11	8 0	104											
21 May to 23 June.	Carlyon's 70 inches single, 192 horse.	1847. Perran Foundry Co. Hocking and Loam.	10 0	1 - 14 D - 14	1 4	–	75,812	19·0	194,000	4·1	357	3,160	44·7	90·5	4·9	12 qts. 182 lbs.	Direct acting engine, drawing perpendicularly. Cylinder over the shaft, 120 fms. of flat rods, 2 balance bobs, and one 19 fms. of 19-in. plunger, as balance. Three boilers, 36 tons. *W. West.* One boiler idle.
				1 - 16 P - 17	42 3	288											
			10 0	1 - 16½P - 17	21 2	288											
				1 - 16 P - 16	31 3	324											
				1 - 14¼D - 18	20 3	256											
			8 0	1 - 10 P - 11	33 0												
				1 - 10 D - 10	21 1												
				1 - 9 D - 10	20 0												
SOUTH CARADON.	Pearce's 45 inches single, 85-horse.	1844. Hodge - - W. West.	9 0	1 - 10 P - 9	34 3	95	21,496	12·0	–	–	–	1,340	–	–	–	qts. lbs.	Drawing perpendicularly. Main beam over the cylinder, 1 balance bob, and working 2 air machines, 16 inches square. Two boilers, 12 tons. *W. West.* Counter idle.
				1 - 6 P - 7	13 0	33											
				1 - 7½P - 7	35 2	44											
				1 - 8 D - 7	43 5	44											
			8 0	1 - 6¼D - 7	15 3	44											
				1 - 6 D - 7	16 3	44											

11 May to 18 June.	Jope's 40 inches single, 71-horse.	Unknown -	9	0	1 - 9 P - 10	42	3	57	19,016	15·1	307,000	5·6	139	1,010	52 0	29·1	4·1	qts. lbs.	Drawing perpendicularly. Main beam over the cylinder, 1 balance bob, and working 1 air machine, 21 inches square. One boiler, 10 tons. *W. West.*
					1 - 9 P - 9	23	4	44											
			9	0	1 - 8½P - 9	36	0	44											
					1 - 8 D - 9	5	0	44											
STRAY PARK -	60 inches single, 141-horse.	1838. Sandys & Co. Grose.	9	0	2 - 11 P - 11	82	3	91	40,173	12·6	–	–	–	–	–	–	–	qts. lbs.	Drawing perpendicularly. Main beam over the cylinder, 2 balance bobs, and 1 V bob, and working 1 air machine, 17 inches diameter. Two boilers, 24 tons. *Grose.* Boiler and steam pipes partly uncovered, and one-eighteenth allowed.
					1 - 10½P - 11	33	0	79											
			8	0	1 - 9 P - 9	37	1	64											
					1 - 9 D - 9	20	0	64											
					1 - 6 D - 6	6	0	28											
					1 - 8¼D - 8	8	4	44											
TINCROFT -	56 inches single, 131-horse.	1832. Harvey & Co. J. West.	10	0	1 - 13 P - 12	27	3	108	56,345	18·3	–	–	–	–	–	–	–	qts. lbs.	Main beam over the cylinder. Drawing 204 fms. perpendicularly, and the rest diagonally, 1 balance bob at surface, 2 ditto and 2 angular bobs underground, working 2 air machines 22 inches square. Two boilers, 22 tons. *J. West & Son.*
					1 - 12 P - 13	35	3	108											
			8	0	1 - 12 P - 13	23	3	95 85											
					1 - 12 P - 13	19	4	87											
					1 - 12 P - 13	20	1	91											
					1 - 10 P - 11	24	0	71											
					1 - 9 P - 8	16	5	37											
					1 - 7⅛D - 8½	10	0	36											
					1 - 8 D - 8	14	0	36											
					1 - 8 P - 9	12	0	36											
					1 - 6½D - 7	10	0	37											
	North, 36 inches single, 58-horse.	1830. Harvey & Co. Gribble.	7	0	1 - 6 P - 5	23	2	29 34	23,323	19·6	–	–	–	–	–	–	–	qts. lbs.	Main beam over the cylinder. Drawing from one shaft perpendicularly 65 fms., and the rest diagonally, 1 balance bob at surface. One boiler, 11 tons. *J. West & Son.* Counter idle.
			6	0	1 - 7⅛P - 9½	41	4	71 31											
					1 - 7 P - 9	30	4	37											
					1 - 7 P - 9	20	0	34											
					1 - 6⅓D - 7	21	0	46											
					1 - 8 P - 8	46	3	28											
					1 - 6 D - 7	12	2	28											
					2 - 5¼D - 6	40	0	18											
					1 - 11 P - 7	4	0	28											
					1 - 10 D - 11	15	0												
TRELAWNY - 10 May to 18 June.	50 inches single, 105-horse.	1847. Hodge - W. West.	10	0	1 - 10½P - 13	32	0	154	37,706	18·9	204,000	3·6	142	1,110	69·3	45·7	3·1	10 qts. 150 lbs.	Main beam over the cylinder. Drawing perpendicularly, 2 balance bobs. boilers, 17 tons. *W. West.*
					1 - 10¾P - 13	38	1	101											
			10	0	1 - 11 P - 12	32	0	95											
					1 - 11 D - 12	13	0	95											
					1 - 10 D - 11	14	2	48											
					1 - 10 D - 11	15	0	48											
					1 - 10 D - 11	10	3	48											
					1 - 8 D - 9	12	1	48											
WEST FOWEY CONSOLS. 21 May to 23 June.	60 inches single, 141-horse.	1838. Sandys & Co. J. West.	10	0	1 - 9 P - 9	15	0	–	48,346	15·4	159,000	3·3	198	1,128	61·3	41·3	3·8	qts. lbs.	Drawing perpendicularly from two shafts, main beam over the cylinder, 2 balance and 1 angular bob at surface, connecting 100 fms. of horizontal rods, and 100 fms. of dry rods in shaft. Two boilers, 25 tons. *W. West.*
					2 - 14 P - 17	62	0												
			9	0	1 - 14 P - 14	31	0												
					1 - 12 D - 13	10	0												
					1 - 10 D - 13	13	0												
					1 - 9 D - 13	12	0												

ROTARY ENGINES.

MINES and PERIOD.	Engines and their Power.	When made, Maker's Name, and from what Engineer's Drawings.	Number of Kibbles Drawn.	Average Depth from which they are Drawn.	Average Weight of a Kibble of Stuff in Lbs.	Average Number of Kibbles drawn by consuming 1 cwt. of Coals.	Horse Whim Kibbles of 3 cwt. raised the Average Height by Consuming 1 cwt. Coal.	Number of Strokes and Times each Head lifts per Stroke.	Number of Strokes per Minute.	Length of Stroke in Cylinder, and Diameter of Fly Wheel.	Number of Heads and Average Height Lifted.	Cwts. of Coals Consumed.	Millions of lbs. Lifted 1 ft. high by Consuming 1 cwt. of Coals.	Actual Horse Power Employed.	Weight of Heads, Lifters, &c. in Lbs.	Oil and Tallow Consumed.	GENERAL REMARKS, and SUPERINTENDING ENGINEER'S NAME.
				Fathoms.						*Ft. in.*	*No. in.*		*Lbs.*				
DEVON GREAT CONSOLS.	Josiah, 30 & 16 inches. Sims's combined, 52-horse.	1845. Perran Foundry Company. W. West.	–	–	1,456	–	–	–	–	5 0 14 0	–	–	–	–	–	qts. lbs.	One boiler, 8 tons. *Matthews.* Drawing one half of the time with one kibble, without kibble or chain in the opposite shaft, for which an allowance of 1,500 lbs. is made.
	Anna Maria, 24-inch double, 34-horse.	1851. Nicholls and Williams. Matthews.	–	–	2,352	–	–	–	–	6 0 16 0	–	–	–	–	–	qts. lbs.	Working horizontally. One boiler, 9 tons. *Matthews.*
FOWEY CONSOLS.	Davis's 22 in. double, 29-horse.	1840. Harvey & Co. W. West.	6,034	265·1	1,000	22·0	65·5	–	–	5 0 15 0	–	274	35·0	–	–	3¾ qts. 50 lbs.	One boiler, 7 tons. *W. West.*
	Trathen's 20 in. double, 24 horse.	Unknown -	2,389	100·7	850	24·9	63·0	–	–	4 0 12 0	–	96	12·1	–	–	2½ qts. 30 lbs.	One boiler, 7 tons. *W. West.*
	Powne's 22 in. double, 29-horse.	1841. Harvey & Co. W. West.	3,208	211·2	1,000	18·2	54·1	–	–	5 0 15 0	–	176	23·1	–	–	3¾ qts. 50 lbs.	One boiler, 7 tons. *W. West.*
May Month -	Ray's 18 in. double, 19-horse.	1833. Harvey & Co., W. West.	2,739	183·3	850	22·8	57·7	–	–	4 0 12 0	–	120	21·1	–	–	2½ qts. 30 lbs.	One boiler, 7 tons. *W. West.*
GREAT POLGOOTH.	Brasier's stamps, 35 in. double, 73-horse.	1848. Hodge - - W. West.	–	–	–	–	–	–	–	10 0 25 0	120 10	–	–	–	43,680	qts lbs.	Drawing 30 waggons, 2,800 lbs. each, per day, over an inclined plane, the perpendicular height of 21 feet. Two boilers, 20 tons. *W. West.*
	Gover's stamps, 24 in. double, 34-horse.	1844. Hodge - - Webb -	–	–	–	–	–	– 4·0	–	7 0 15 0	60 10	–	–	–	23,980	qts. lbs.	Two boilers, 10 tons. *W. West.* Eight cwt. of coals allowed for working round buddles.
	Bell's 22 in. double, 29-horse.	1849. Hodge - - W. West.	–	–	1,008	–	–	–	–	5 0 14 0	–	–	–	–	–	qts. lbs.	Working a crusher 4 hours a day, equal to an average load of 3,200 lbs. during the time of working. One boiler, 7 tons. *W. West.*

	Hodge's 22 inches double, 29-horse.	1847. Hodge - W. West.	–	–	1,008	–	–	–	–	5 0 14 0	–	–	–	–	–	qts. lbs.	One boiler, 7 tons. *W. West.* Drawing with one kibble, without kibble or chain in the opposite shaft, for which an allowance of 1,500 lbs. is made.
	West's 22 inches double, 29-horse.	1847. Hodge - W. West.	–	–	1,008	–	–	–	–	5 0 14 0	–	–	–	–	–	qts. lbs.	Drawing a 6-in. lift 6 fms., 2 ft. 9 in. stroke, 442 lbs. days. One boiler, 7 tons. *W. West.* Drawing with one kibble, without kibble or chain in the opposite shaft, for which an allowance of 1,500 lbs. is made.
PAR CONSOLS	Carthew's 24 & 13 inches. Sims's combined, 33-horse.	1843. Harvey & Co. W. West.	2,215	140·6	1,008	26·4	79·2	–	–	4 6 14 0	–	84	18·0	–	–	1½ qts. 20 lbs.	Working a steam capstan occasionally. One boiler, 7 tons. *W. West.*
	Meredith's 24 inches double, 34 horse.	1843. Harvey & Co. W. West.	5,444	187·9	1,008	17·5	52·5	–	–	5 0 15 0	–	311	19·9	–	–	2 qts. 20 lbs.	One boiler, 7 tons. *W. West.*
May month -	Edgecomb's 24 inches single, 27-horse.	1844. Harvey & Co. W. West.	5.134	109·9	1,008	25·7	77·1	446,000	10·0	6 0 13 0	–	144	19·5	–	–	2 qts. 20 lbs.	Drawing 2 fms. 4 ft., 6-in. lift, 4 ft. stroke, 196 lbs. One boiler, 8 tons. *W. West.*
SOUTH CARADON. 11 May to 18 June.	Stamps, 26 inches single, 32-horse.	1838. Thomas & Hodge. W West.	2,310	3·5	1,700	–	–	302,000 5·0	9·4	9 0 20 0	24 10	306	52·0	15·0	12,200	qts. lbs.	Drawing 70 waggons of 1,700 lbs. each per day, over an inclined plane, the perpendicular rise of 21 feet; working a grinder 6 hours per day, equal to an average of 800 lbs. load. One boiler, 8 tons. *W. West.* Idle 36 hours on Sundays, and six hours out of the 24 on other days, and working two jigging machines 10 hours per day; for which an allowance of one ton of coals is made.
May month -	24 inches double, 52-horse.	1839. Thomas - W. West.	3,312 1,018	91·2	1,456 950	11·4	45·3	446,000	10·0	4 6 14 0	–	380	11·0	–	–	qts. lbs.	Drawing 4 fms., 5 in. lift, 3 ft. stroke, 205 lbs. One boiler, 10 tons. *W. West.* Drawing with 1 kibble two-thirds of the time. Boiler and steam-pipes uncovered, for which an allowance of one-tenth of the coals is made.

ROTARY ENGINES—*continued.*

MINES and PERIOD.	Engines and their Power.	When made, Maker's Name, and from what Engineer's Drawings.	Number of Kibbles Drawn.	Average Depth from which they are Drawn.	Average Weight of a Kibble of Stuff in Lbs.	Average Number of Kibbles drawn by consuming 1 cwt. of Coals.	Horse Whim Kibbles of 3 cwt. raised the Average Height by consuming 1 cwt. Coal.	Number of Strokes and Times each Head lifts per Stroke.	Number of Strokes per Minute.	Length of Stroke in Cylinder and Diameter of Fly Wheel.	Number of Heads and Average Height Lifted.	Cwt. of Coals Consumed.	Millions of lbs. Lifted 1 ft. high by Consuming 1 cwt. of Coals.	Actual Horse Power Employed.	Weight of Heads, Lifters, &c., in Lbs.	Oil and Tallow Consumed.	GENERAL REMARKS, and SUPERINTENDING ENGINEER'S NAME.
				Fathoms.						*Ft. in.*	*No. in.*		*Lbs.*				
TIN CROFT -	Sump whim 24-inches single, 27-horse.	1832. Harvey & Co. J. West.	–	–	–	–	–	–	–	5 0 13 0	–	–	–	–	–	qts. lbs.	One boiler, 7 tons. *J. West & Son.* Drawing with one kibble.
	Martin's 18½ inches double, 20-horse.	1825. Perran F. Co. Michell.	–	–	672	–	–	–	–	5 0 13 0	–	–	–	–	–	qts. lbs.	One boiler, 7 tons. *J. West & Son.*
	North, 20-inches double, 24-horse.	1835. Perran F. Co. J. West.	–	–	900 700	–	–	–	–	5 0 16 0	–	–	–	–	–	qts lbs.	One boiler, 7 tons. *J. West & Son.*
	Stamps 36-inches double, 77-horse.	1835. Sandys & Co. J. West.	–	–	–	–	–	– 5·0	–	9 0 22 0	64 10	–	–	–	39,712 2,709	qts. lbs.	Drawing a 17-in. plunger lift 4 fms., 7 ft. stroke, and 40 waggons per day, over an inclined plane, the perpendicular rise of 15 ft. Feeding with cold water, and working 90 trunkers 10 hours a day, equal to 21,000 lbs. load, lifted 1 ft. during the time of working. Three boilers, 34 tons. *J. West & Son.*
TRELAWNY -	24 and 14 inches, Sims's combined horizontal, 34-horse.	1848. West & Son, W. West.	–	–	–	–	–	–	–	5 0 16 0	–	–	–	–	–	qts. lbs.	Working horizontally. One boiler, 7 tons. *W. West.* Drawing with 1 kibble three-fourths of the time without kibble or chain in the opposite shaft, for which an allowance of 1,500 lbs. is made.

Appendix, No. 14.

COPY of all ADVERTISEMENTS published by the Metropolitan Board of Works since its formation, calling for Tenders for dealing with the Sewage, as well as of all Reports or other information in any way affecting or relating to the applications which have been made to the Board for the Sewage; and of all Reports by the Officials of the Board or the Main Drainage Committee upon the said Plans or Proposals.

ADVERTISEMENTS published by the Metropolitan Board of Works since its formation, calling for Tenders for dealing with the Sewage.

App. No. 14.

Metropolitan Board of Works.—Contracts for the Sewage of the Metropolis.—The Metropolitan Board of Works hereby give notice that they will meet at the Council Chamber, Guildhall, in the City of London, on Friday the 6th day of July next, at 12 o'clock at noon, and will be prepared to receive and consider tenders or proposals from any parties who may be desirous of contracting for deodorizing or otherwise treating the sewage conveyed by the main outfall sewers of the Metropolis, so as to render the same innocuous, or for removing and disposing of such sewage, with a view to its application to agricultural or other purposes.

Parties who may wish to submit tenders or proposals to the Board may obtain plans showing the points at which the sewage will be delivered, or may be taken, with particulars of the estimated quantities at the several points, and other information, on application to Mr. J. W. Bazalgette, Engineer of the Board, at the office of the Board, No. 1, Greek-street, Soho, before four o'clock on Thursday the 4th day of July next, upon payment of the sum of 5 *s.*; and any tender or proposal sent in after that hour will not be received.

The tender or proposal may have reference to all or any of the points of outfall indicated in the plan; and each tender or proposal must contain an explicit description of the proposed mode of dealing with the sewage, and stating the terms offered for the use of it, the parties intending to contract, the amount of capital which will be invested in the works, the duration of the contract, and such other particulars as shall render the proposal intelligible.

Any party with whom the Board may decide upon contracting, will be required to enter into a contract, containing amongst others, covenants for taking the whole of the sewage contracted for at such points and localities as may be sanctioned and approved by the Board, for effectually removing and disposing of the sewage, and for making the requisite communications, and executing all other works or matters which may be necessary for carrying on the operations of the contractor at his own cost and expense; and also covenants for taking and disposing of the sewage and conducting all operations in such a manner as not to create a nuisance, and so as not to contravene the provisions relating to nuisance and other matters contained in the Metropolis Local Management Act, 1855, the Metropolis Local Management Amendment, 1858, or any Acts which may be passed for amending the same, and for subjecting the contractor to penalties in case of non-compliance with the contract; and also for enabling the Board in case of nuisance to revoke the permission granted, and determine the contract without compensation to the contractor for loss or damage, or on other grounds.

The Board do not bind themselves to accept any tender or proposal; and the party whose tender may be accepted will be required to provide two approved sureties to be bound jointly and severally in the sum of 5,000 *l.* for the due performance of the contract.

(signed) *John Pollard,*
Clerk of the Board.

No. 1 Greek-street, Soho,
8 May 1860.

Metropolitan Board of Works.—The Metropolitan Board of Works hereby give notice that on Friday the 8th May next, they will receive tenders for the disposal of the sewage discharged by the main outfall sewers. All tenders must contain a full description of the works proposed, and must be accompanied by a plan and section showing the several details. The Board will further require full information as to the manner in which the sewage is to be treated and employed; and if by irrigation, as to the distribution of the sewage, the quantity and locality of the land over which it is to be distributed, the points at which the sewage is to be intercepted, the daily quantity to be employed, the mode of effecting junctions or communications with the Board's sewers, the provisions against floods, failure of pumping power, or other defect in the company's works, the mode of deodorization, or otherwise preventing the sewage from becoming a nuisance or injurious to health, the amount of capital to be invested, the number and value of the shares, duration of the contract, and royalty agreed to be paid to the Board. The Board will not enter into any contract, or make any concession of sewage to any parties, unless they take all steps necessary for carrying their project into effect

App. No. 14.

effect within a time to be named by the Board; and in the event of failure to do so, any agreement or concession on the part of the Board shall be void and of no effect; and in any contract, provision must be made to secure to the Board the return of the sewage works, and the full power to re-let and deal with the same, and so that the Board may, in case of any failure of the contractors or their operations, be left to their full rights, and without any cost to the Board. The tender must contain the names of two or more sureties, to be approved by the Board, who shall be jointly and severally bound in a competent sum for the due performance of the contract, and for the efficient execution of the works in accordance with the provisions and subject to the limitations of the Metropolis Local Management and Main Drainage Acts, and for indemnifying the Board against all loss, damage, or injury, claims for compensation, or legal proceedings arising out of the said works or other operations of the contractors. The Board will not bind itself to accept the highest or any tender.

The plans and sections of the sewers can be seen, and all information obtained, at the office of the Engineer of the Metropolitan Board of Works at their office in Spring Gardens, between the hours of nine a.m., and four p.m.; or on Saturdays between nine a.m., and two p.m.

The tenders are to be addressed to the Clerk of the Board, and must be delivered at this office before four o'clock on Thursday the 7th May next, and no tender will be received after that hour.

By order,
(signed) *John Pollard*,
13 March 1863. Clerk of the Board.

Sewage of the Metropolis.—The Metropolitan Board of Works hereby give notice, that they have extended the time for receiving tenders for the disposal of the sewage of the metropolis until Friday, the 10th July next. All tenders must contain a full description of the works proposed, and must be accompanied by a plan and section showing their several details. The Board will further require full information as to the manner in which the sewage is to be treated and employed; and if by irrigation, as to the distribution of the sewage, the quantity and locality of the land over which it is to be distributed, the points at which the sewage is to be intercepted, the daily quantity to be employed, the mode of effecting junctions or communications with the Board's sewers, the provisions against floods, failure of pumping power, or other defect in the Company's works, the mode of deodorization or otherwise preventing the sewage from becoming a nuisance or injurious to health, the amount of capital to be invested, number and value of the shares, duration of the contract, and royalty agreed to be paid to the Board. The Board will not enter into any contract, or make any concession of sewage to any parties, unless they take all steps necessary for carrying their project into effect within a time to be named by the Board; and in the event of failure to do so, any agreement or concession on the part of the Board shall be void and of no effect; and in any contract, provision must be made to secure to the Board the return of the sewage works, and the full power to re-let and deal with the same, and so that the Board may, in case of any failure of the contractors or their operations, be left to their full rights, and without any cost to the Board. The tender must contain the names of two or more sureties, to be approved by the Board, who shall be jointly and severally bound in a competent sum for the due performance of the contract, and for the efficient execution of the works in accordance with the provisions and subject to the limitations of the Metropolis Local Management and Main Drainage Acts, and for indemnifying the Board against all loss, damage, or injury, claims for compensation, or legal proceedings, arising out of the said works or other operations of the contractors. The Board will not bind itself to accept the highest or any tender. The plans and sections of the sewers can be seen, and all information obtained, at the Office of the Engineer of the Metropolitan Board of Works, at their office in Spring Gardens, between the hours of 9 a.m. and 4 p.m.; or on Saturdays between 9 a.m. and 2 p.m. The tenders are to be addressed to the Clerk of the Board, and must be delivered at this office before 4 o'clock on Thursday, the 9th July next, and no tender will be received after that hour. Parties who have already sent tenders, and who may be desirous of altering or amending their proposals, may obtain them on application to the Clerk of the Board.

By order,
(signed) *John Pollard*,
11 May 1863. Clerk of the Board.

REPORTS and other Information in any way affecting or relating to the Applications which have been made to the Board for the Sewage.

17, Great George-street, Westminster,
8 August 1856.

To the Chairman of the Metropolitan Board of Works.

Mr. Chairman,

IT is understood that, at your next meeting, the position of the outfalls for the sewage of the metropolis is to be finally decided, and it has occurred to me that the present is a proper time for directing your attention to another system of outfalls, by means of which the two great conditions demanded by the public will be complied with, namely, the purification of the Thames and the utilization of the sewage as manure.

I therefore take the liberty of submitting for your consideration the accompanying plan, showing the direction of the new outfall sewer.

My proposition is, to do away with the main drainage sewers and reservoirs on both sides of the Thames, and to construct a conduit capable of conveying the whole sewage of the metropolis from

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from the pumping station at West Ham, passing through the rich agricultural districts of Essex to a point on the sea-shore between the estuaries of the Crouch and the Blackwater Rivers; this conduit to be made available for the purposes of sewage irrigation throughout its entire length until it reaches the German Ocean.

From West Ham to a place called Battle Bridge over the River Crouch, the conduit would pass through the uplands of Essex, and would be constructed as a tunnel or covered canal. From this place to its mouth it would run through the marshes adjoining the River Crouch, a district almost devoid of population, but extremely rich in agricultural produce, and where upwards of half a million acres of land may receive the benefit of the sewage of the metropolis. For this latter portion of its length it would be sufficient to construct the conduit generally as an open canal, following the course of the river until it arrives within two miles of Burnham, from whence it would be diverted in a north-easterly direction to the sea.

The sewage of the whole of the southern district may be collected at a pumping station near Southwark Bridge, and be carried by means of pipes over the river to the Aldgate sewer, through which it would flow to the proposed main conduit.

The expenditure for this work would not exceed 1,600,000 *l.*, a sum not greater than the cost of the works required for discharging the sewage into the Thames, even at the distance already contemplated, together with an amount representing the increased annual expenditure for pumping to the outfalls, and for the deodorization of the sewage, but which would be unnecessary if the proposed scheme is adopted.

In order to prove their confidence in the system now proposed, responsible parties are prepared to execute the new outfall sewer to receive the whole sewage of London, within a period of four years from the commencement of the work, either for the sum of 1,600,000 *l.*, to be certified by your engineer as the work proceeds, or for an annual rent equal to four per cent. of that amount, to commence after the work is ready for use.

I have, &c.
(signed) *John R. McClean.*

Outfall Sewer, proposed by Mr. McClean to the Chairman of the Metropolitan Board of Works, in Letter of the 8th August 1856.

THE proposed outfall sewer will commence by a junction with the one proposed by your engineer near the pumping station at West Ham, at a point where the high level intercepted sewage, and the low level sewage, pumped up, flow through the same channel. The level of the top water at the junction will be 16 feet above Trinity datum, as shown on the plan of your engineer. The conduit will pass over the North Woolwich Railway by means of an iron aqueduct, and under the Tilbury Railway, near its junction with the Eastern Counties Railway; the railway will be raised two feet for the purpose of allowing the water to be maintained at a level 14 feet 6 inches above Trinity datum in the conduit at the time of its maximum discharge. After passing under the Tilbury line it will proceed through Ilford, crossing Barking Creek above the navigable part of the river, and thence, without interfering with the level of any road, to the marsh land near Battle Bridge, in the valley of the Crouch, to which place the tide at present flows. The conduit will be a covered sewer, 24 feet diameter as far as the marshes, from whence, with the exception of a length of about two miles covered near Burnham, it will be an open sewer until it reaches the German Ocean. The fall will vary between five and six inches per mile, and the velocity between two and three feet per second, or between 1½ and 1¾ miles per hour, and there will be an uninterrupted discharge at all times of the tide. No pumping will be required between West Ham and the German Ocean.

The conduit will be capable of discharging 52,000 cubic feet per minute, which is the maximum sewage and rainfall estimated by your engineer to flow through the sewers of the Northern, Southern, and Western Districts of the Metropolis.

To the Honourable the Board of Metropolitan Works.

The Memorial of the undersigned Occupiers of Land, in the Southern Division of the County of Essex;

Showeth,

THAT the agricultural interests of this country is now brought into direct competition with the corn-producing countries of the world.

That the only way in which your memorialists believe that they can now hope to meet such competition is by high cultivation.

That the Metropolitan district contains within itself an annual and increasing source of fertilizing matter, which, if properly applied, would be to your memorialists and others of the greatest possible utility.

That your memorialists have noticed that two schemes are before your Board—the one to discharge the sewage of the Metropolis into the Thames at or near Barking, and thus throw away many hundred thousands of tons annually of fertilizing matter, whilst the other (Mr. McLean's) proposes to render the same available for agricultural purposes.

Your memorialists therefore beg your Honourable Board to consider well the advisability of the latter scheme, which would, in the opinion of your memorialists, render highly productive a large district of country nearly adjoining the Metropolis, and whilst freeing the Thames from a large amount of polluting matter, would confer a great benefit not only upon your memorialists but upon the community at large.

Wm. Hutley, Witham.
Wm. Crush, Chignal, St. James.
(And 71 others.)

Metropolitan Board of Works,
Sir, 27 September 1856.

THE Metropolitan Board of Works will, on Wednesday the 1st October, proceed to the consideration of your memorial with reference to a scheme for conveying the sewage of the metropolis to a point on the sea shore of Essex, between the estuaries of the Crouch and Blackwater Rivers; and I am directed to request that you may be present in the Council Chamber, Guildhall, on the day named, App. No. 14. named, with a view to affording such further information or explanation as may be required by the Board.

I am, &c.
(signed) *C. H. Woolrych,*
J. R. M'Clean, Esq. Clerk of the Board.

Somerleyton Hall, near Lowestoft,
My dear Sir, 8 November 1856.

I WROTE you some time since on Mr. M'Clean's plan, and so strongly am I impressed that it is the right thing to do, that with the hope that the Chief Company, yourself, and your colleagues will yet adopt it, I have, with my friends, directed Mr. Day, of 43, Parliament Street, to give the Parliamentary notices, so that if you should approve we may be in time for this next Session.

I should be prepared to execute it for a fixed sum; and if you will pay 4 (four) per cent. on it, and let us have the manure from the sewage, I will guarantee its being carried out.

I believe you will find it the best plan in every point of view, and leave the purification of the Thames not a matter of doubt but of certainty.

I am, &c.
(signed) *S. Morton Peto.*

METROPOLITAN SEWAGE.

43, Parliament Street, Westminster.
Sir, 11 November 1856.

I BEG leave to forward you, for the information of the Metropolitan Board of Works, a copy of a notice which I propose to insert in the papers in anticipation of an application to Parliament in the ensuing Session.

The promoters have requested me in forwarding the notice to state, that in publishing it without previous arrangement with the Board, they are actuated solely by the desire of avoiding the loss of a year, in case the Board and the Government should (when its merits are fully detailed) approve of the plan.

The plan proposed is:—

1. To carry the outfall sewer to sea without any pollution of the Thames.
2. To apply the manure without deodorizing it to agricultural and other purposes, free from nuisance to any one.
3. The proposed company will guarantee the execution of the works at a fixed sum.

I will, about the 29th instant, forward a copy of the plans and sections for the consideration of the Board, and will then make a further communication on the subject.

I am, &c.
(signed) *George Game Day.*
W. L. Woolrych, Esq.,
Metropolitan Board of Works,
1, Greek street, Soho.

(Copy Notice.)

METROPOLITAN SEWAGE.

(Outfall to the Sea.)

(CONSTRUCTION of Outfall Sewer from West Ham to the German Ocean, on the Essex coast, between Rivers Blackwater and Crouch, incorporation of company, or powers of construction by the Metropolitan Board of Works, arrangements with Metropolitan Board of Works, sale of sewage, power to lay pipes along roads, reclamation of lands on the said Essex coast, repeal or transfer of powers of South Essex estuary, and Reclamation Act; Amendment of Acts.)

NOTICE is hereby given, that application is intended to be made to Parliament, in the ensuing Session, for leave to bring in a Bill to incorporate a company, and to grant to such company powers to carry into execution the works hereinafter mentioned, or any of them, or any part or parts thereof (that is to say):—

To make and maintain an outfall sewer or conduit, commencing at or near to and on the south side of certain mills called the Abbey Mills, in the parish of West Ham, in the county of Essex (at which place the pumping station of the Metropolitan Board of Works is proposed to be made), passing from, in, through, or into the several parishes, townships, and extra-parochial places of Stratford, West Ham, Plaistow, Leyton, Wanstead, Eastham, Little Ilford, Great Ilford, Barking, Dagenham, Romford, Hornchurch, Upminster, Rainham, Wennington, Avely, Cranham, North Ockendon, South Ockendon, Great Warley, Little Warley, Childerditch, Bulphan, otherwise Bulvan, Ingrave, East Horndon, West Horndon, Dunton, Laindon Hills, otherwise Langdon Hills, Laindon, otherwise Langdon, Leigh Chapel, otherwise Lee Chapel, Great Burstead, Little Burstead, Billericay, Ransdon Crays, Bassildon, Ramsden Bellhouse, Downham, Nevendon, Wickford, South Hanningfield, West Hanningfield, East Hanningfield, Runwell, Rawreth, Rawreth Gildable, Runwell Gildable, Rettendon, Woodham Ferris, Bicknacre, Stow St. Mary's, otherwise Stow Mary's, otherwise Stow Maries, Purleigh, Cold Norton, North Fambridge, Snoreham, Latchingdon, Althorne, Mayland, Cricksea, or Creeksea, Burnham, Ostend, Southminster, Asheldham, Dengie, and Tillingham, or some of them, in the said county of Essex, and terminating in the sea, at or in the place called Swire Hole, upon that part of the sea coast which is situated between the confluence with the sea of the Rivers Crouch and Blackwater, or the estuaries of such rivers, at or near, or abutting upon that part of the shore or seabank adjoining the said parish of Tillingham, which is situated between the Tillingham Coast Guard Station and the outfall of the drain called Hutson's Outfall.

To make and maintain in connection with, and at any places upon the line of such outfall, sewer approaches, wharves, communications, and other works and conveniences, sumpts, pumping, and deposit stations, and other works for the reception and deposit of the sewage, and for facilitating its use, conversion, and distribution for the manuring of land, or for other purposes, and to authorise the Company to lay down pipes under, along, or upon the sides of any of the turnpike or public roads within any of the parishes, townships, or extra-parochial places before specified, for the better use, conversion, distribution, and application of the said sewage for agricultural and other purposes; and it is intended to incorporate with the Bill the provisions of "The Waterworks Clauses Act, 1847," with respect to the breaking up of streets for the purpose of laying pipes, and to take further and other powers with reference thereto.

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In such Bill powers will also be sought for the following purposes (that is to say):—

To cross under or over, and to alter the line or levels of, stop up, or divert, either temporarily or permanently, turnpike and other roads, rivers, canals, bridges, navigations, river and sea-banks, sewers, drains, watercourses, and railways, for the purposes of the intended undertaking, and more particularly to cross over or under, and alter the levels of, the North Woolwich Branch of the Eastern Counties Railway, and of the London, Tilbury, and Southend Extension Railway, and to stop up or alter, and use certain parts, arms, or branches of the River Crouch and North Fambridge Creek, and of certain creeks or cuts running into, out of, or from the same within any of the parishes or places before-mentioned; also powers for the compulsory purchase of land and houses required for the purposes of the undertaking, to the extent of all or any of the lands and houses, to be defined on the plans hereinafter mentioned, and to enable the intended Company to purchase, by agreement, any other lands; to authorise the Company to sell to the owners, lessees, and occupiers of any lands upon or near the line of the outfall sewer, and to any other parties, or to agree with such owners, lessees, occupiers, and parties for the sale of sewage for agricultural and other purposes, and to confer certain powers upon the Company with reference thereto.

To authorise the Company to receive from any sewer, river, drain, or stream crossed by or near to the outfall sewer, the surplus or flood-waters thereof, and to authorise the payment to the Company of any sum of money in respect thereof by the Commissioners of Sewers or any other party having the jurisdiction over any such sewer, river, drain, or stream.

To authorise the Metropolitan Board of Works and the Company to agree as to the payment by the Metropolitan Board of Works of an annual sum of money for the conveyance of the sewage from the metropolis, or for the payment of a gross sum in such manner as may be arranged, or as may be provided in the Bill; and to enable such Board to charge the sum of money so agreed to be paid upon the rates or funds applicable to the maintenance and improvement of the sewerage of the metropolis, and to raise money upon mortgage for any such payments and for such and other purposes of the Bill, it is intended to amend the Act for the better local management of the metropolis (18 and 19 Vict., cap. 120), to enable the Metropolitan Board of Works to undertake and execute the several works proposed to be comprised in the said Bill, or any part thereof, either in lieu of or in conjunction with the intended Company, and to exercise all or any of the powers proposed to be conferred by the said Bill, and to raise money on mortgage of the rates authorised to be received by them under such last-mentioned Act, or in such other way as may be authorised in the Bill, or to enable the Company to lease or sell the undertaking to the Metropolitan Board of Works, and to enter into other permanent or temporary arrangements of any nature as to the construction, maintenance, and use of the outfall sewer, and works connected therewith.

To enable the Company to warp, embank, and reclaim from the sea certain marshes, sandbanks, and waste lands, called respectively Saint Peter's Flat, Dengie Flat, and Ray Sands, at, near to, or adjoining the termination of the said outfall sewer, and to vest the same lands in the Company, and to extinguish all rights and privileges connected therewith, which said lands and works will extend from or near a point in the parishes of Saint Lawrence and Bradwell, or one of them, in the said county of Essex, at or near the mouth of the River Blackwater, called Sale's Point, on the north, to or near to a place called Lubber's Hole, at or near to the mouth of the River Crouch, in the said parish of Burnham, on the south, and such lands so to be warped, embanked, and reclaimed will be situated in, near, or adjoining to the several parishes, townships, or extra-parochial places of Saint Lawrence, Bradwell-near-the-Sea, Saint Peter's-on-the-Wall, Dengie, Southminster, Tillingham, Asheldam, and Burnham, all in the said county of Essex.

To repeal, wholly or in part, "The South Essex Estuary and Reclamation Act, 1852," and to dissolve the Company established by such Act, and to extinguish all rights and privileges connected therewith, or to alter and amend the said Act, and to authorise or require such Company to transfer their undertaking, or any part thereof, to the Company to be incorporated by the Bill, under such provisions or stipulations as may be agreed upon or provided in the said Bill, and to enable the Company so to be incorporated to carry into execution the powers of such Acts with reference to the undertaking, or any part thereof so transferred, and in the event of such transfer, to revive and extend the powers granted by the said Act or any of them, and to extend the time limited by such Act for the compulsory purchase or taking of lands and the completion of works.

Plans and sections describing the line or situation and levels of the said outfall sewer and works, and the lands in or through which the same may be made, and the lands to be reclaimed, together with books of reference to such plans, containing the names of the owners or reputed owners, lessees or reputed lessees, and occupiers of the lands and houses which may be taken under the powers of the Bill; and a copy of this notice, as published in the "London Gazette," will, on or before the 29th day of November instant, be deposited for public inspection with the Clerk of the Peace for the county of Essex, at his office in Chelmsford; and on or before the same day a copy of so much of the said plans, sections, and books of reference, as relates to each of the parishes, or extra-parochial places, in or through which the said intended outfall sewer and works are proposed to be made, or the lands to be reclaimed are situated; and also a copy of this notice, as published in the "London Gazette," will be deposited as follows (that is to say): In the case of parishes, with the parish clerks of such parishes respectively at their places of abode; and in the case of any extra-parochial place, with the parish clerk of some parish adjoining thereto at his residence.

Printed copies of the intended Bill will, on or before the 31st day of December next, be deposited in the Private Bill Office of the House of Commons.

Dated this 8th day of November 1856.

George Game Day,
43, Parliament-street,
Solicitor for the Bill.
Henry Shaw,
Solicitor, Bellericay,
Local Agent.

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Somerleyton Hall, near Lowestoft,
24 November 1856.

My dear Sir,

I shall feel particularly obliged by your putting the enclosed letter before the Chairman and Commissioners at their meeting to-morrow.

I am, &c.
(signed) *S. Morton Peto.*

J. H. Woolrych, Esq.

P.S.—I shall be in London to-morrow (Tuesday) and Wednesday.

To the Chairman and Commissioners of the Metropolitan Board of Works.

Gentlemen,

I AM most anxious that, before you finally decide on the outfalls for the metropolitan sewerage, you should have all the points of Mr. M'Clean's plan fully before you, and I shall be greatly obliged by your allowing me to attend you with that gentleman, to afford you the necessary explanations. The imperative importance of the subject will, I trust, be considered a sufficient excuse for my thus troubling you.

The whole of the plans and sections of the proposed outfall sewer to the German Ocean being now completed, you can have all the necessary information with accuracy, so that your decision may be taken without delay.

The levels taken show such a difference between the height of the top water of the aqueduct at West Ham, as shown on the sections of the engineer of the Metropolitan Board of Works, and the level of the spring tides of the German Ocean at the point of discharge, as will admit a velocity of nearly three feet per second. The sewer will be capable of discharging the whole of the sewerage and rainfall estimated by the engineer of the Metropolitan Board, without any additional pumping, in a continuous current and at all times of the tide. With the assumed velocity of three feet per second, there will not be any deposit of sewerage except at places selected specially for that purpose; and this velocity is not only sufficient to prevent the deposit of any soil, but is equal to removing broken stones as large as those used generally for metalling roads.

As regards estimates, the sum of 1,600,000 *l.* will be sufficient for executing the works, &c. between West Ham and the sea.

The locality of the outfall is admirably adapted for chemical works of every description, if requisite, in connection with the sewerage, and is so far removed from habitations or places where houses are likely to be built that such works could never become a nuisance, and it has the advantage also of proximity to the Rivers Crouch and Blackwater, both of which form excellent harbours.

From the best data I can obtain I am led to believe the proposed outfall at B, on the Metropolitan Plans, will cost:—

		£.
1st Estimate,	Extension to Barking -	340,000
Do.	Reservoir - - -	171,800
Do.	Reservoir on south side -	103,000
Do.	High-level sewer on south side not required if pumping is done at Southwark Bridge -	199,226
	Carried forward - -	814,026

	£.
Brought forward - - -	814,026
Additional cost of outfall sewers if taken to Halfway House, as stated in last report, 25th September - - -	326,330
	£. 1,140,356

The comparison will therefore stand, in outlay, at 1,600,000 *l.* as against 1,140,356 *l.*; and in making this comparison, I assume that the cost of conveying the sewerage from the south side, including the sewerage of Greenwich and Woolwich, into the outfall sewer of the north side, will not be greater than the cost of the proposed outfall sewer on the south side. Indeed, instead of a difficulty in adopting the system of sewerage proposed by your engineer for the south side to the proposed northern outfall sewer, it will much simplify the work to collect the sewerage at Southwark Bridge, instead of at Deptford Creek, as it will not be necessary to make any portion of the sewer below low-water, as at present proposed by the engineer of your Board.

You will, by the adoption of Mr. M'Clean's plan, entirely get rid of all reservoirs and pumping at the outfall, and the Thames will be left perfectly clear of all sewerage matter; and the proprietors of land in South Essex have shown, by the memorial so extensively signed, their great anxiety for the adoption of the plan, so that no opposition of a local nature need be feared by you if, after deliberation, you should approve the plan.

I have no desire in any way to be connected with the execution of these works; my only object being that the plan should have ample consideration given to it. I feel a deep interest in the subject, from having sat two years on your Commission when the plans of the north and south sewerage were determined, but that you may feel the difference in expense is not an insuperable barrier to the execution of this great work, I am willing (with my friends)—if you will pay, by way of rent, in perpetuity, for the use of the outfall sewer to the German Ocean, an interest of 5 (five) per cent. per annum on the cost of your own outfall and works connected therewith to the Thames—to construct the outfall to the sea, you having the free use of it for the rent so paid.

I make this offer that the subject may be treated on its own merits—an advantage fully equivalent to any difference being obtained at the outfall at the sea: for outside the present sea-wall, and lying between the Rivers Blackwater and Crouch, is an extensive foreshore capable of being reclaimed, and there is an area of about six miles long and one mile broad, or nearly 4,000 acres, which might be at once treated in this way, and there are upwards of 20,000 acres more, which may be similarly treated from time to time by the sewerage not otherwise utilised being discharged over it. Thus that which will, in the case of the Thames outfall being adopted (treat it as you will), become a nuisance on the South Essex shore will become a public benefit and a source of income.

It appears to me this great subject should be grasped with a determination so to treat it that the works executed should be sufficient for all time, and able to meet the contingency of any future increase of the metropolis, and any little delay at the present moment in coming to your determination will be far more than counterbalanced by the right conclusion being arrived at.

I have, &c.
(signed) *S. Morton Peto.*

Somerleyton Hall, Suffolk,
24 November 1856.

Metropolitan Board of Works, Greek Street,
27 November 1856.

My dear Sir,

THE Chairman desires me to state that your letter of the 24th November, on the plan of Mr. M'Clean, for the outfall of the metropolitan drainage, is entered in the agenda for to-morrow's meeting, and will be read to the Board, in order that it may be fairly presented to the Board, and not excluded from discussion, which posibly might be the case if the reading of it were deferred till Tuesday, when the modified plan to be submitted to the First Commissioner is appointed for discussion, and will probably be decided on.

I am, &c.
(signed) *E. H. Woolrych.*

Sir S. Morton Peto, Bart., &c. &c. &c.

METROPOLITAN DRAINAGE.

Outfall to the Sea.

17, Great George Street, Westminster,
2 December 1856.

Sir,

In the report in "The Times" of the 29th ultimo of the proceedings of the Metropolitan Board of Works, held on the 28th ultimo, it is stated that you (the Chairman) "considered it was desirable the public mind should be disabused on one or two matters which had been misunderstood respecting the system of the outfall sewer proposed by Mr. M'Clean."

As I am equally desirous that the public should understand the subject thoroughly, I feel confident that you will excuse me for endeavouring to remove some of the erroneous impressions which you have formed respecting the system referred to.

You proceed to say that "he (Mr. M'Clean) proposed to bring all the sewage on the south side of the river to one great reservoir at the foot of Southwark Bridge." If I had suggested, either by letter or in conversation, the construction of a reservoir at Southwark Bridge, your remarks would have been just, as the people of Southwark ought to be alarmed at any such project; but so far from having recommended a work of that description, I have invariably spoken of the continuous flow of the sewage of the metropolis, at all times of tide, without reservoirs, as forming the leading feature of my plan.

Again you say that "the sewage is to be lifted up 70 or 80 feet into tubes crossing Southwark Bridge, and dropped again into another sewer, which would carry it to West Ham, where again it would have to be lifted into a second sewer and carried down to Crouch River." The suggestion I made was to carry the sewage over the bridge by means of pipes and thence into the Aldgate Sewer, which is a high-level sewer on the north side. If you were of opinion that I proposed to pump up the sewage of the south side and then let it down again on the north side of the Thames, and afterwards pump it up again at West Ham, I need not feel surprised at your opposition to the project, but I did not propose it. The height (60 feet) to which the sewage will be raised at Southwark Bridge is sufficient to send it to the sea without any additional pumping, and the cost of laying pipes and enlarging the sewer to West Ham will not exceed the cost of the main outfall sewer on the south side between Deptford and Plumstead.

Again you say: "Mr. M'Clean, on being asked whether he knew that the direction of the sewers on the south side was from west to east, did not appear to have entered into that question, or into the question how the sewage could be collected from all the outlying districts to the foot of Southwark Bridge."

It is true at your meeting I did not enter into details which arose, not from ignorance of the direction of the sewers, but because I considered the inquiries were connected with the internal drainage of the metropolis, which ought to be carried out by your engineer, and not by the company who proposed to construct the outfall sewer between West Ham and the sea. I stated that from the information about the levels and direction of the sewers which I had acquired on a former occasion, I was prepared to say that the cost of connecting the sewers on the south side with the Southwark Bridge pumping station would not exceed the cost of connecting them with Deptford pumping station, as proposed by your engineer.

I will now add that the cost of pumping engines at Southwark Bridge Station will not exceed the amount you require for pumping two-thirds of the sewage of the south side 38 feet high at Deptford, and the whole sewage say 28 feet at Erith.

The annual cost of pumping may be a little greater at Southwark Bridge Station than at the two other stations, but from Southwark Bridge Station the sewage of the metropolis will be sent out to sea, or will be used beneficially for agricultural purposes throughout a district upwards of 42 miles in length and of considerable width; while from Deptford it will flow to Erith and into the Thames there, and the cleansing of the reservoir will be a perpetual cost and nuisance.

Besides, by placing the pumping station in the centre of the district at Southwark Bridge, the south side high-level sewer may be altogether abandoned, and the saving applied to the main outfall sewer between West Ham and the sea, as stated in Sir Morton Peto's letter.

I hope these explanations will remove some of the erroneous impressions which you appear to entertain respecting my proposal, and convince you that Sir Morton Peto had not lent himself to a "deceptive scheme," but had taken the question up, as you say, "from a desire to promote the general object which the Board had to accomplish."

I am, &c.
(signed) *John R. M'Clean.*

To the Chairman of the
Metropolitan Board of Works.

3 December.

P.S.—Since writing the above remarks, the report of your engineer on the Government scheme of outfall has been published.

The alteration in the quantity of sewage and rainfall to be provided for is so great, that it places the outfall to the sea in even a more favourable position, when compared with the outfall sewers and reservoirs at Erith and Rainham, than before the publication of the report.

The quantity of sewage and rainfall estimated for both sides of the Thames in the former reports was 51,000 cubic feet per minute; it is now reduced to 8,500 cubic feet per minute; consequently the outfall sewer between West Ham and the sea will not require to be more than 10 feet diameter, instead of 24 feet diameter. The high-level sewer on the north side, from its junction to the Aldgate Sewer to West Ham, will not require to be enlarged for the purpose of receiving the whole sewage and rainfall of the south side of the Thames, and the pipes over Southwark Bridge will not require to be more than three feet diameter, instead of six feet diameter.

As this is a public matter, a copy of my letter is transmitted to the public journals.

Sir, 2, Pembroke-road, Kensington.

In answer to the advertisement issued by the Metropolitan Board of Works for tenders for the disposal of the sewage discharged by the main outfall sewer, I beg to lay before the Board the following tender for dealing with the sewage.

My proposal proceeds upon the discovery of a process by which a most valuable portable manure can, without difficulty and at comparatively small expense, be produced from urine. This involves the collection of the urine of the metropolis in as undiluted a state as possible, and hence the necessity of discovering a plan to ensure such collection from the houses and other receptacles, and the conducting of it to a locality adapted for the purpose of carrying on the process by means of which the manure is produced.

This I propose to accomplish by a very simple and inexpensive system applicable to every house, and the use of pans to waterclosets which ensure the urine and fœces being conducted separate and distinct the one from the other. This system will be readily understood by reference to a plan herewith.

By this means the urine is brought to the sewers through which I propose to conduct it by a system of pipes (analogous to the system of pipes of waterclosets, but working in the reverse direction, and without pressure, and by gravitation only) connected with and contained within the drains, sewers, main and intercepting sewers, to the outfall at Barking Creek, which might be an eligible locality for carrying on the process by which the manure is produced.

The same plan, already referred to, shows a portion of a sewer, with the urine-pipe to carry the urine along the side of the sewer, together with the junction-pipe from the house.

From the most careful investigation and accurate calculations, I find that the metropolis would yield upwards of 1,000,000 tons of urine per annum; I propose to estimate it at 1,000,000 tons. Every 33 tons of urine would produce, by my process, one ton of manure, yielding therefore, in round numbers, 30,000 tons of solid manure per annum.

This manure (which I am prepared to prove, is of almost threefold value compared to guano, and possesses the great advantage of being perfectly soluble) I estimate as worth 33 *l.* per ton, which, upon 30,000 tons, will produce a gross return of 1,000,000 *l.* sterling.

The cost of producing the manure from the urine would be 5 *l.* per ton.

The other component parts of the urine could, at a trifling additional expense, produce, independent of the manure obtained, most valuable products: amongst others, purpurate of ammonia, or murexide, a magnificent purple dye, and worth 1,000 *l.* a ton; and I estimate this article would be produced at the rate of one ton per day, yielding 365,000 *l.* per annum.

Without including any other return, the manure and murexide would, together, produce a gross return of about 1,365,000 *l.*

The capital required for putting up the appliances for collecting the urine from the houses and other receptacles, bringing down the system of pipes for conducting the urine to the ultimate place of reception, of erecting the requisite buildings and apparatus for producing the manure would, I estimate, amount to 1,500,000 *l.* sterling.

The result of dealing with the urine alone, would be as follows:—

Manure - -	£.1,000,000	
Cost of Production	150,000	
	850,000	
Murexide - -	365,000	
		£.1,215,000
Allow Interest on the Capital of 1,500,000 *l.* at seven per cent.		105,000
Leaving a Net Surplus to deal with, and derived from urine alone, of - - -		£.1,100,000

With regard to the other portion of the sewage of the metropolis, that is to say, the mixture of surface-water, street débris, fœcal and other refuse matter, they would be conducted through the sewers as at present, and conveyed to Barking Creek, there to be treated by the lime process with a view to the utilisation of the product as manure. The value of this manure, however, would not approach that produced from urine, and would entail a loss in its production. The quantity of this manure produced would be about 25,000 tons per annum, which would be worth about 5 *l.* 10 *s.* a ton, but would cost in its production 6 *l.* per ton, entailing a loss of 10 *s.* per ton, and, consequently, a total loss of about 12,500 *l.* per annum: the loss thus resulting from dealing with the portion of the sewage upon which I am now observing I should propose to charge against the profit resulting from the urine.

After making the most ample allowance for every expense attending the working and carrying out of the system, the result of dealing with the whole of the sewage in the mode explained would, I assert with the most perfect confidence, yield at least a net profit of not less than 1,000,000 *l.* per annum, after allowing interest at seven per cent. on the estimated capital of 1,500,000 *l.*

This profit I propose to deal with as follows:—

That I should receive a percentage thereon on a graduated scale.

That one-half of the balance, after deducting such profit, should be paid to the Board of Works, to be applied partly towards a reduction of the general and local rates, and partly towards the formation of a reserved fund with a view to the ultimate redemption of the debt contracted by the Board in the execution of the works undertaken by them.

The remaining half to be for the benefit of the shareholders in the company formed for providing the capital to carry out the system explained.

The advantages and merits I claim for my plan are—

First. The simplicity of the system and the small outlay involved compared with the results obtained.

Second. The production of a portable manure, perfectly soluble, combining properties which render it almost of threefold value of guano, which might, if necessary, be disposed of at a price to supersede guano, and which, as that article will be exhausted in a few years, will be more than a substitute.

Third. An immediate reduction of the general and local rates, and ultimate redemption of the expenditure incurred by the Board of Works.

I would earnestly urge the Board not to put this plan aside as the dream of a mere enthusiast. I am prepared to attend the Board of Works and demonstrate the perfect facility of my proposal.

I herewith enclose a statement explaining at length the proposed mode of collecting the excretory matter of the Metropolis, and twenty-two tables embodying the scientific data upon which my calculations are based which I request you to peruse.

I am, &c.
(signed) *J. L. W. Thudichum*, M.D.

To the Clerk of the
Metropolitan Board of Works.

On an improved mode of collecting Human Voidings, with a view to their application for the benefit of Agriculture and the reduction of Local Taxation. By *John Louis William Thudichum*, M.D., Member of the Royal College of Physicians. With 26 Statistical Tables.

When the House of Commons, in the course of last Session, resolved to appoint a Committee for the purpose of inquiring into the best means of utilising the sewage of towns, with a view to the reduction of local taxation and the benefit of agriculture, it proposed to re-open the inquiry into a task which, as was evident from the Blue Book of 1857, had already been proved to be impracticable by the most ample analytical proceeding of men of science, and the most costly failures of private and public enterprise. To those well acquainted with all the bearings of the question the result of the inquiry, so far as its purpose was expressed in its programme, could not be doubtful for one single moment. To those, however, who believed that the inquiry could not be limited to the subject of its title, a way appeared now open by which a conviction, latent or clearly developed, in every mind could be made the motive for logical action; the conviction was this,—that the excrements of man are of the greatest value for agriculture; that by the present system of house and town drainage they are lost, and that their removal involves a tax upon the community; that by their discharge into rivers they pollute them and make them a nuisance and source of disease. The conclusions to which this conviction should have led all inquiries are of so simple a nature, and arrived at by so straight and short a way, that it is astonishing to perceive they were missed by all persons who were called upon or volunteered to give the result of their experience and the elaboration of their reflections. But the attempt to deal with the primary question perished in the use of the word "sewage," just as the matter which it was desired to preserve perished in the complex mixture called sewage. Sewage was assumed to be an unalterable entity, a decree of fate from the very moment that those who proposed to deal with it lost sight of its real nature as a foolish and short-sighted manufacture of man. The recognition of this error constituted the first step towards the only possible solution of this question. A metaphysical operation had to precede practical inquiry; it led to the conviction that a return to first principles was absolutely required before the excrements of man could be utilised with a view to either of the two laudable objects of the resolution of the Commons. As sewage contains nothing that is valuable for agriculture or any other human purpose, beyond the excrements of men and animals, the inquiry of the Commons should properly have been into the best mode of utilising human excrements for the purposes indicated in their resolution. But this inquiry could not come before them or occur to their mind's eye, unless another also was instituted by them, namely, into the manner in which human excrements could be collected, so as to allow their being applicable to any purposes whatsoever. Deliberation, however, on this subject became impossible by the universal adhesion to that household institution, the water-closet. The only alternative which was seen was between retaining the present closet and its apparatus, and returning to the cesspool just departed under the pressure of legal enactment, and the chagrin of public and private expenditure. The just abhorrence of this inexpressible chamber, its smells, its diseases, its contaminations of every kind, left no doubt that the choice of all comfort-loving persons would fall upon the retention of the hydraulic apparatus, even at the cost of an annual loss of 5,000,000*l.*, and an additional expenditure of 5,000,000*l.* of money for guano and artificial manure, and many millions more for the purchase of the grain and meat of other countries. To such a fearful resolution was society chained by the most stupid of all inventions that ever interfered between man and his first duties. The closet pan took possession of the mind by keeping common sense a prisoner. This circumstance involved another metaphysical operation, namely, the liberation from the dogma of the closet pan and a return to the origin of that which the pan was by the inventive genius of man constructed to receive. To a man who argues, as a common man would express it, by contraries, to that independent inquirer who investigates the circumstances, which speak against his opinion rather than those which appear in its favour, to such a man it must appear that the inventor of the closet pan performed an experiment expressly for his use. Supposing him to have inquired into the intentions of nature when she fixed the directions in which the excreta of men were to leave their bodies, and supposing him to have adapted receptacles for their preservation to the intention, as recognised by the observation of the performing parts and of the actual operation, and supposing him to have tested the logic of this apparatus by the question of how he could defeat the objects of nature, he would immediately have fallen upon the closet pan.

But as men generally were not thus independent and thinking, their estrangement to nature and her provisions could be effected by a gradual process of breaking their minds to the tolerance of loathsome places and of foolish processes for their use. First was erected the enclosure termed the privy, then came the wooden seat with the round hole in it; at first it was kept detached from habitations, until, when the habitation itself was deprived of surrounding space and became a town house, the necessary room with a cesspool attached became part of the habitation. To guard his habitation from the contamination which he himself had necessitated man flew to the water-closet, and robbed of its resources his field, and nature of her due. Thus, when men retired from nature and shut themselves up in towns, they became alike foolish and filthy.

This was so little a result of unavoidable circumstances that, on the contrary, it must have involved a total forgetfulness of the oldest habits and laws of mankind. The Jews in the Desert had yet the spatula, with which each man dug a hole for his fæces on the top of the declivity down which he had determined that the urine should flow; thus was Moses great as the greatest of the givers or upholders of nature's sanitary laws. The Rediffs in the Turkish camp used yet in the beginning of this century to avail themselves of a similar arrangement. A hole was dug in the ground, and a tent placed over it, slabs of stone formed a footing, and left a narrow canal between; the hole received the solid, which was immediately covered by a shovelful of the available earth close by. The fluid excretion ran by a narrow ditch to where it sank into the ground. Even the instinct of animals taught reasoning man a lesson of cleanliness, by the burying of their ordure; but neither from his ancestors nor from brute creation, nor from those whom he despised as inferior in what he called civilisation, did the western man, the man of the Christian era, take example. He dirtied everything by what he cast from himself, and what is worse, remained dirty upon his own body. He removed pollution a little further from his habitation by sending it into his rivers; but, by a revenge of Providence, it turned back upon him, and in his water, which God had made the emblem of purity, he shuddered to drink his likeness—a filtered pollution. So man was defiled, not only by what came from him, but also by what entered into him.

This state of affairs is recognised by all to be a matter of the greatest reproach to our generation, and consequently all are willing to remedy the evil which they recognise, if the means for doing so were but found to-day or to-morrow. The subject is not now any longer beneath the notice of the proudest statesman, and industrious citizens even cater the applause of vestrymen by flattering their hopes for cheaper bread and lesser taxes. Royal Commissioners have travelled through the land, and taken notice of the cry of the population, the bills of morbility and mortality, the experiments of the industrious, or the schemes of the speculator. The highest tribunal of the kingdom at last has recognised, by the appointment of a Committee of Inquiry, that the subject is of national importance, and is fully aware that it would meet with the unanimous support of the people in towns and country if it were to support, by legal enactments, a feasible plan for escaping the reproach of recklessly throwing away what every one knows must constitute the wealth of the nation at all times, and be the principal and unfailing resource of supply at those times when gold itself would cease to be of value. There is only one way in which the question can be solved, namely, by having the closest regard to nature, not only to her mechanical arrangements, by which she disposes of the excreta of man, but also to the chemical peculiarities with which she endowed the solid part on the one, the fluid part on the other hand. Nature separated these two excretions by propelling them from the outlets in directions which diverge at an angle of 45 degrees, more or less. It is consequently the first step in any rational proceeding to uphold that separation, and to examine its purpose by scrutinizing its effects. Even if the fluid excretion were not propelled by a special contractile power, but were allowed to fall in a perpendicular direction like the fæces, it would still be separated from the latter in the male sex by a distance of six inches, and in the other sex by one of three inches, the same distance in fact at which nature has placed the respective outlets. This arrangement makes it an easy task for a practical mind to adapt an apparatus for the necessities of man, and for man to adapt his position to the apparatus. The separation of urine from fæces, by means of an apparatus is, however, a very subordinate point in the main question at issue. By far the greater quantity of urine among it, that which is most important for the purpose, the night and morning urine, is passed at times and into vessels quite independently of defœcation. It may be said that five-sixths of all the urine passed is voided into chamber-pots and urinals, or might at least be voided into either of these receptacles with less trouble than into any other. One-sixth part of the urine is passed during the process of defœcation, and here again it is passed mostly at the beginning of the passage of fæces, is retained during the actual transit of the scybalon, and its discharge is only completed when the contractions of the rectum have ceased, and nervous energy and room return to the urinary organs and passages. Nature thus by ordaining the discharge of urine at frequent intervals quite independent of defœcation, and by restricting the quantity discharged with defœcation to one-sixth part of the total quantity discharged, has imposed a kind of compulsion upon man to collect this excretion in a separate vessel.

This injunction men obey everywhere, particularly in towns; and London, as an example, collects some millions of pints of urine daily in chamber pots, remembers that its colour indicates its value by its similarity to the precious metal, but then comes the lapse produced by ignorance and folly. We pour it down the water-closet, mix a pint with 500 or 1,000 pints of inert or dirty water, and then grapple with our self-made problem, at the outlet of our sewers, under philanthropic announcements and impossible proposals, and are astonished and mortified when all our inquiries and the combined wit of the prominent men of the kingdom, the experiments of Royal Commissions, the discussions of learned societies, and the examination of Parliamentary Committees, lead to no result. Had they investigated the subject backwards to its origin, and looked less to the prude susceptibility of a society which, to remove these matters altogether from its notice, would not shrink from forgetting its duty towards its own posterity, they would have seen that the chamber pot is a penny savings bank, that the large amount of matter of great value deposited daily therein, must be collected and united to a larger capital with which to fertilise the fields, or feed chemical manufactories.

This is the title of the first and principal lesson which we have to teach the world.

The Economy of the Chamber Pot.—This consists, in the first instance, in a kind of police to keep its proper contents, the renal secretions, uncontaminated by water slops, and other impurities. All these should go directly into the place of their final destination, or take the intermediate route through the slop-pail. This purity once secured, the urine becomes a matter easily to be dealt with. It loses entirely the repugnant appearance and attributes which bad habits have associated with it, and what is of the greatest importance, it loses that aptitude to ammoniacal decomposition, which the admixture of other matters readily engenders. This, in its turn, prevents the incrustation of vessels which otherwise so easily ensues, and in this manner one step secures a series of consequences, all favourable to our purpose, promotive of domestic comfort and diminishing household labours. The common slop-pail per example, which through the almost unavoidable incrustation with lime salts of the fatty acids from soap, and the imbibition of this crust by ammoniacal substances, frequently becomes a nuisance on a small scale, is by this prohibition to mix the pure contents of the chamber pot with its water and soap—slops at once transformed into a clean and never-smelling receptacle.

But as the contents of the chamber pots are necessarily emptied at least once a day, more commonly twice a day, and in some cases more frequently during the 24 hours, and as it would be very inconvenient to carry every chamber pot to the place where its contents are finally sent out of the house, it becomes necessary to employ a separate large vessel for collecting the contents of every chamber pot of the house, and carrying them therein to the place of egress. This vessel is of the shape and size of a common slop pail, with a moveable sunk top, serving as a funnel and filler, with a spout for pouring out its contents, and a fixed handle at the side opposite the spout to hold by during the pouring out of the contents, and an arched moveable top handle for carrying it. This vessel is termed the chamber pail. By means of this chamber pail, every householder has it in his power to cause five-sixths of the valuable fluid excreta to be collected, and to be further disposed of at his absolute will and pleasure. If he purchases a cask, or an iron tank, and causes them to be trapped by the easiest means, so that no smell can be evolved by any chance, he may collect any quantity during any length of time he pleases, and at suitable periods either apply the contents of the cask or tank to his own lands, or sell them to the agriculturist, to be disposed of by this latter according to his convenience. The householders can in this way, without any particular trouble, in the course of each year collect urine to the value in money of 10*s.* per head, from which it is evident that the produce of the first year's collection, in an average family of five persons, would more than repay the cost of the whole apparatus, chamber pail, cask, and tank, removal and application to the land. The farmer, on the other hand, would buy only value, as he could for a trifling sum ascertain the amount of matter valuable for his purpose contained in a given quantity of collected material. The second, and all following years, would return to the householder the full revenue of 10*s.* per head of his household. Of the urine passed by the inhabitants of London, a quantity of 3,000 *l.* sterling in value could, by these means, be collected every day. The simplest arrangements, which need not exceed a few pounds in expense for every house, would enable the inhabitants of London to collect a value of 1,000,000 *l.* sterling per annum, without offence to their health, their feelings, or their noses. The same holds good for every other town or village, or single house, everywhere, a value of 10*s.* per head can be collected and returned to the land from which it was abstracted. Even if legal enactments were not to be obtained for the plan which I shall presently submit for the collection, in one spot, of the excretions of entire communities, if no Board of Works could be moved to allow the sewers to perform their most valuable functions, and assist in producing a return to the burdened taxpayers, even in that most improbable case, an expense of 16*s.* for every house, sunk in the purchase of two car-boys and one chamber pail, would enable a society of private individuals to collect, with the concurrence of intelligent householders, value to the amount of 10*s.* for every adult individual in every house, and return to the householders one half of the profits, after deducting sinking fund on capital, interest, and cost of removal and application; and such half of the profits would, in all cases, amount to a considerable portion of the sewers' rates; and if every householder would do his duty fully, the whole amount of his sewers' rates might then be saved by his own energy and industry.

But for towns provided with a system of sewers, a much cheaper plan for collecting the urine of the population can be adopted, by providing a system of pipes, one from every house, which, entering the sewer by the drain, shall there be connected with a main, the main to meet its equals at the junction of the sewers, to combine with large mains, and the whole to conduct their fluid contents to suitable stations in the course or at the outfalls of the sewers. At all the stations or outfalls the urine might be collected in tanks and carted away by road or rail, or lifted and sent to any distance by a system of conduits and reservoirs in the country. Even in towns where there are no sewers, or where only the smaller number of houses drain into the sewers, a system of pipes might be laid down, and a profit realised upon the collection and removal of the excretions. Thus the town of Birmingham, which now expends upwards of 8,000 *l.* per year to clear the privies of its population of filth of little value, could, by carrying out this proposition, make an income of at least the amount of its present expenditure, possibly to the amount of 100,000 *l.*, a sum still far below the theoretical value of the fluid excretion of its population. The details of this proposed arrangement are no less simple than its general features. Excluding at present the consideration of the improvements to be adopted as regards the construction and working of water-closets, we have only to provide one stationary outlet for the contents of the chamber pail. This is a funnel leading to a pipe of lead bent in the usual manner, so as to preclude the possibility of the regurgitation of any gases that might be evolved in its continuity. The funnel

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funnel must be moveable, so as to admit of being cleaned by water, hot water, acids and alkalies. The pipe to which it leads must, moreover, in the better class of houses, admit of being closed by a cork or plug provided for the purpose. This funnel, termed the "chamber funnel," conducts the urine through the bent into a half-inch lead pipe, which runs through the house drain into the sewer, there to join the main or uroduct. The servant carrying the collected renal excretion in the chamber-pail, takes the moveable funnel to the place where the "chamber sink" is fixed, which may be in any suitable place, the area, the coal cellar, the water-closet, or where there are several, or one of them, or the place specially fitted for a common slop sink, or a lead flat, or any place in any yard, fixes the funnel upon the pipe, opens the cock and pours the fluid down, removes the funnel, takes funnel and pail where she can clean them with water, and the operation, simple, easy, and cleanly in the extreme, is completed. By this duty and its fulfilment, the housemaid ascends a step in the scale of society, for from being a servant of individuals, she becomes a servant of the community, and promotes not only but administers the most vital affairs of the State. The uroduct which receives the pipes proceeding from the single houses, is an iron pipe running along the wall of one side of each sewer, a little above the mark of the ordinary dry weather flow of sewage. The pipe is supported and fixed by cast-iron bearings fixed in the brickwork; it is somewhat egg-shaped on a section, with a flat and removable top-lid, which can be fixed water-tight, or removed in case any obstruction should require the interior of the pipe to be examined. I do not myself apprehend any obstructions, and could be satisfied with round closed pipes. But as I find engineers generally very apprehensive of incrustation, I think it but right to provide a remedy even against the objectors, if it should not be required against the objections. The incrustation of common sewage pipes in the Fulham experiment has no bearing whatever upon the behaviour of uroducts in the sense here propounded. Sewage is alkaline, urine acid; sewage contains lime salts of fatty acids from soap, which adhere to any article they touch, and leave incrustation with great readiness, as can be learned by the observation of any slop-pail.

The behaviour of public urinals is also no guide towards a conclusion as to the behaviour of urine in the uroduct; the urine is there spread over a large surface, and allowed to dry in part and to decompose. The earthy phosphates are thereby deposited, and form incrustations by the crystallization of the ammoniaco, magnesia phosphate. This retains decomposed urine, which acts as a ferment to all following portions of healthy urine. Deposit and ferment might easily be removed by the application of a little dilute nitric acid, mixed with some nitrous acid, and one daily careful washing. The uroduct, so far as it is of lead, could be freed from all deposit by the occasional application of some hydrocholoric acid; the iron main would suffer by this agent, and when the most improbable case of its obstruction should arise, must be cleaned by mechanical means. The size and capacity of the main uroducts must be calculated for every sewer according to the number of persons living in the houses draining into it. The maximum flow would be between nine and eleven o'clock, at the time of the arrangements of the bed-rooms. Another rise would take place towards five o'clock, p.m., when the evening preparations begin to take place.

Supposing that the urine of the part of London north of the Thames were destined to collect in three mains, lying in the three intercepting sewers on the high, middle, and low level, a one foot in diameter pipe in each of them would admit of the gravitation of the whole of the urine of these millions towards a common or three different receptacles, without there ever being any pressure in any of the pipes. But the possibility of such pressure can be provided against by a few perpendicular pipes rising from the top of the main, and admitting of the escape into the sewers of any excess of fluid. As the uroduct has to be fixed at the side of the sewer, where it would not obstruct the flow of the sewage, and not assist in the formation of deposits, and also be out of the way of the persons who have to pass through, or to work in these canals, it would be necessary to conduct the pipes from the houses lying on the side opposite to that side of the sewer along which the uroduct runs across the sewer along its roof in the form of an arch, and to let it descend into the uroduct in all cases where the top of the arch of the pipe is below the level of the chamber sink.

This arrangement is fully exhibited in the drawing representing a section of Parliament-street and Victoria-street Sewer, and of a house on the left, in which the chamber sink has been fixed in the area. The same drawing also exhibits the arrangement by which that part of the urine, which passes during defecation, can be collected and united with the other five-sixths of the whole quantity. It consists of a common water-closet, with only a peculiar pan, being divided in two parts, an anterior one for the reception of the urine, and a posterior one for the reception of the fæces, in the usual quantity of water.

The special arrangements of this pan and its proportions must be left for special description, and are best shown by a large drawing, or a model of the pan itself. Suffice it to say, that the anterior funnel conducts the urine into a lead pipe, which, after the usual S shaped bend, passes downwards along the large closet pipe, and in or near the drain, joins the pipe from the chamber sink. The posterior division is provided with valves in the usual way, and washed with water in the usual way. An ounce or two of water are provided for washing the anterior funnel of the uroduct.

This simple arrangement was indicated by me many years ago, in my work on the Pathology of the Urine. It was also elaborated in France, and the water-closets of the buildings of the Exhibition of Paris of the year 1855 were actually provided with it. The pans worked exceedingly well, and there are many persons in London who can testify from personal experience as to the perfect success of the operation for which they were intended. The exhibitor, M. Chevallier, obtained two prizes. He did, however, not exhibit his article in the last London Exhibition. A Swede, however, a M. Klemming, from Stockholm, exhibited portable closets, evidently intended for medical use, and the use of invalids, in which the separation of the urine from the fæces is effected by a divided pan, the receptacle for the urine being trapped by a bent tube, the apperture for the fæces by a valve which opens when the person who performs sits down upon the top ring, and closes when the operation is completed, and the person leaves. The French apparatus I have not been able to obtain, but of the Swedish manufacture I possess a very excellent specimen.

This arrangement for carrying out the intentions of nature as to the separation of the fæces is, however, of much more importance in cases where no water-closets as yet exist, and the fæces and urine together pass into common receptacles. Here the receptacles have simply to be divided, or two separate moveable receptacles have to be substituted; the one a cask or tank, or a carboy to receive the urine from the uroduct, the other a wooden box, a cask, or an iron box, to receive the dry fæces, dried further by the admixture of certain simple agents, inexpensive and within reach of everybody.

The pan forming the funnel of the copoduct is in this arrangement divided in two lateral halves which separate when a handle is pulled, and let the contents pass into the box below, whose cover opens by the pull of the same handle, and closes again when the pan closes and the handle is down. The succession of the single steps of defecation into this machine is as follows:—A conical paper bag, made for the purpose, is placed into the pan. A little dry earth and lime is by means of a scoop from a scuttle placed into the bag, the excretory process next deposits the fæces upon the earth, the urine is propelled into the uroduct. The operation, including the deposition of papers, completed, another quantity of earth and lime is thrown upon the fæces, whereby they are completely deodorized, the valve is drawn, the bag and contents fall into the box below, the valve closes, and all is finished. Those who are very particular can fix a small suction and pressure pump to wash the funnel for the urine with an ounce or two of water. This proceeding is positively cleaner and more agreeable than that of the water-closet. The earth never recoils as does the water, when the fæces touch it frequently, and hits with its cold spray the most sensitive part of the organ engaged in the matter. The dilatation of the sphincter, which is so often interrupted by this accident, is not interfered with on the dry closet. The urine not touching the fæces, the amount of smell which rises from the fæces is not increased by the carriage of steam which rises from the urine. The scybala are finally deodorised by matter which, being alkaline, combines with their mostly acid parts, and are preserved from decomposition by the subtraction of moisture effected by the dry earth. Both receptacles can either be removed entire and substituted by fresh ones, or their contents may be emptied into larger ones, as often as may be requisite by the accumulation of matter, without difficulty, smell, or annoyance of any kind. The fæces and earth can be deposited upon any land, or in any dung-pit, upon any compost heap, or, be dug or ploughed under immediately; the urine also may be immediately distributed on land, or collected in large tanks and reservoirs, to await its final destination.

The process here indicated is only the continuation of the process adopted by nature, and as the agency employed is of the simplest and cheapest kind, and its materials are either ready furnished by nature or easily obtained in the largest quantities.

The greatest difficulty, namely, the collection of the fæces without dirtying a receptacle requiring the agency of water for cleaning, is met by the adoption of a receptacle which may perish with the matter. Earth dry, or dried common earth, the most powerful hygroscopic substance known, surpassing even sulphuric acid and absolute alcohol in its affinity for water, is used to mummify the fæces, which in the same moment are touched by lime or chalk, to neutralise their acid properties and arrest their decomposition. The odour actually present is also absorbed by the earth, and the development of any further odour is prevented by the combination and exsiccation. This process is eminently adapted to satisfy the requirements of single houses in the country, to villages and smaller towns. Many of the 11/12 of the houses of Birmingham and Manchester, not yet provided with water-closets, can apply this new apparatus at small cost, and sell the whole of the yearly proceeds at the rate of 12 *s.* per head of each family. To the more densely populated parts of larger towns and the dense parts of London, this dry process is, however, not so applicable as the water-closet with funnel and uroduct, and the chamber sink and uroduct in the sewer.

TABLE I.

AVERAGE Quantity of URINE and Valuable Ingredients discharged by a Healthy Adult Person in 24 Hours.

Average quantity of Urine	(Tab. II.)	32.5 fluid oz.
	Women	42. „
„ Urea	(Tab. III.)	512.5 grains.
	Women	390. „
„ Uric acid	(Tab. IV.)	8.57 „
	Women	7.3 „
„ Creatinine	(Tab. V.)	12.0 „
„ Hippuric acid	(Tab. VI.)	19.0 „
„ Phosphoric acid	(Tab. VII.)	48.8 „
	Women	56.2 „
„ Sulphuric acid	(Tab. VIII.)	31.1 „
	Women	30.2 „
„ Chloride of Sodium	(Tab. IX.)	210. „
	Chloride in women	98.9 „
„ Ammonia	(Tab. X.)	10.52 „
„ Potash	(Tab. XI.)	58.2 „
„ Magnesia	(Tab. XII.)	3.12 „
„ Lime	(Tab. XII.)	3.55 „

TABLE II.

AVERAGE Daily Quantity of URINE passed by Healthy Adult Males, between 20 and 40 Years of Age.

OBSERVERS.	Amount in Fluid Ounces.	The Number of Days Furnishing the Mean is in no Case less than Six.	OBSERVERS.	Amount in Fluid Ounces.	The Number of Days Furnishing the Mean is in no Case less than Six.
Prout - - -	35		V. Frangue - -	54	
Bird - - -	38		S. Vogel - - -	57	
Schirks - - -	38		Beneke, 2d obser. -	59	
Hammond - -	39½		Beigell - - -	59	
Parkes - - -	40	Mem. of 20 days' observation on one person in London.	Thudichum - -	61	Mem. of 163 observations on two persons in London.
Berquael - - -	44				
Leraan - - -	44		Mosles - - -	65	
Roberts - - -	46		Sal. Lehmann - -	67	
Schneller - - -	46		C. I. Lehmann - -	71	
Genth - - -	47		H. Ranks - -	71	Mem. of 30 observations on one person.
Kaupp - - -	47				
Beneke - -	49		Boecker - - -	81	
Neubauer - - -	49				
Valentin - - -	50		Mean in 24 hours	52½	
Kernes - - -	52				
Bischoff - - -	54		Mean per hour -	$2\frac{1}{10}$	

TABLE III.

AVERAGE Daily Quantity of UREA voided by Healthy Adult Males between 20 and 40 Years of Age.

OBSERVERS.	Amount in Grains.	Average of not less than Six Days each, often 10 to 20.	OBSERVERS.	Amount in Grains.	Average of not less than Six Days each, often 10 to 20.
Bequael - - -	286.1		Beigell - - -	551.0	
Parker - - -	371.5		S. Lehmann - -	551.8	
Beneke - - -	378.2		Mosles - - -	558.9	
Scherer - - -	416.8		Rummel - - -	563.6	
Levann - - -	432.3		Kerner - - -	588.2	
Moos - - -	444.6		Ranke - - -	656.0	
Boeker - - -	444.9		Hammond - -	670.0	
Schneller - - -	458.2		Genth - - -	688.0	
Scherer (2d series) -	460.4				
C. J. Lehmann - -	501.6		Mean in 24 hours	512.4	
Neubauer - -	511.2				
Kaupp - - -	535.1		Mean per hour -	21.0	
S. Vogel - - -	540.0				
L. Frangue - -	541.3		Nitrogen - -	46,677°/₀	
Bischoff - - -	541.9				

TABLE IV.

AVERAGE Daily Quantity of URIC ACID, CREATININE, XANTHINE, SALKINE, HIPPURIC ACID, and other matters discharged by Adult Healthy Males, of between 20 and 40 Years of Age.

Boeker estimated the total of these at - - - -	247.6 grains.
Scherer „ „ „ - - - -	375.7 „
Scherer, in a second case „ „ - - - -	318.0 „
Rummel „ „ „ - - - -	236.7 „
Beiquael „ „ „ - - - -	180.0 „
Parker, deducting volatile salts, uric acid, and estimates extractives at - - - - - - - - -	154. „
These matters and cases in women of 15 to 40 - - -	149. „

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Table IV—*continued.*

AVERAGE Daily Quantity of URIC ACID excreted by Healthy Adult Males.

OBSERVERS.	Amount in Grains.	OBSERVERS.	Amount in Grains.
Neubauer (1st obser.) - -	4.32	Genth - - - - -	9.35
Beneke - - - - - -	5.40	Ranke - - - - -	10.00
S. Lehmann - - - - -	6.11	C. S. Lehmann - - - -	10.80
Schultin - - - - - -	6.79	Hammond - - - -	14.14
Neubauer (2d obser.) - - -	7.56	Kerner - - - - -	14.94
Beiquael - - - - - -	7.64		
Boecker - - - - - -	7.64	Mean - - -	8.57
L. Vogel - - - - - -	7.72		
Kaupp - - - - - -	8.01		

Nitrogen, 33.33°/o=2.85 grains, which, after putrefaction, might yield 3.46 grains of ammonia.

TABLE V.

AVERAGE Daily Quantity of CREATININE excreted by Healthy Adults.

OBSERVER.	Amount in Grains.
Thudichum - - - - - - - - -	12.

Nitrogen, 37.17°/o=446 grains, which may yield 5.41 grains of ammonia.

TABLE VI.

AVERAGE Daily Quantity of HIPPURIC ACID excreted by Adults.

OBSERVERS.	Amount in Grains.	
Liebig - - - - -	9	"In about the same quantity as uric acid" (857).
Lehmann - - - - -	9	
Weismann - - - -	34.5	When living on mixed food.
The same - - - -	17.	When living on animal food.

TABLE VII.

AVERAGE Quantity of PHOSPHORIC ACID excreted by Healthy Adults in 24 Hours.

OBSERVERS.	Amount in Grains.	OBSERVERS.	Amount in Grains.
Neubauer (1st obs.) - - -	24.70	Neubauer (3rd obs.) - - -	47.86
Dunklenberg (1st obs.) - -	32.94	Genth - - - - -	49.33
Kaupp - - - - -	35.46	Kerner - - - - -	52.75
Dunklenberg (2d obs.) - - -	35.62	Krabbe - - - - -	52.85
Mosles - - - - -	36.48	S. Vogel - - - - -	54.04
Beneke - - - - -	39.21	Breed - - - - -	57.62
Neubauer (2d obs.) - - -	39.94	Winter (1st obs.) - - -	57.92
Ranke - - - - -	41.53	Winter (2d obs.) - - -	65.13
Aubat - - - - - -	43.23	Hegar (2d obs.) - - - -	71.63
Hammond - - - - -	43.66	Mosles (2d obs.) - - - -	75.81
Boecker - - - - -	45.13	Winter (3d obs.) - - - -	79.07
Beneke - - - - -	45.46		
Hegar (1st obs.) - - - -	45.57	Mean - - - -	48.80
Sick - - - - - -	47.26		

This gives for 1,000,000 persons per annum 1,135.9 tons, value at 14 *l.* per ton (1½ *d.* per lb.), 15,902 *l.* 12 *s.*

TABLE VIII.

AVERAGE Quantity of SULPHURIC ACID excreted by Healthy Adult Men in 24 Hours.

OBSERVERS.	Amount in Grains.	OBSERVERS.	Amount in Grains.
Berquerel - - - - -	17.34	Buchkeim (2d case) - - -	32.50
Parker - - - - -	20.67	Krause (2d case) - - - -	35.05
Kaupp - - - - -	21.03	Boecker - - - - -	35.56
Beneke - - - - -	24.70	Kerner - - - - -	38.26
Krause (1st case) - - - -	26.57	Neubauer (2d case) - - -	38.29
Buchkeim (1st case) - - -	26.88	Hammond - - - - -	38.47
Duhrnberg - - - - -	28.85	Mosles - - - - -	40.91
Neubauer (1st case) - - -	29.79	Genth - - - - -	41.14
S. Vogel - - - - -	30.88		
Clare - - - - - -	32.02	Mean - - - -	31.11
Gurner - - - - -	32.33		

This for 2,000,000 adult males gives 4,081 tons per day, value 37 *l.* 6 *s.*, at 1 *d.* per lb., 9 *l.* 6 *s.* 8 *d.* per ton.

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TABLE IX.

AVERAGE Quantity of CHLORINE excreted by Adults in 24 Hours.

OBSERVERS.	Amount in Grains.	OBSERVERS.	Amount in Grains.
Parkes (1st case) - - -	51.87	Neubauer - - - - -	136.87
Parkes (2d case) - - -	58.05	Wilde - - - - -	147.60
L. Vogel - - - - -	92.06	Hammond - - - - -	154.80
Buchkeim (1st obs.) - - -	105.45	Kaupp - - - - -	155.94
Buckheim (2d „) - - -	105.60	Kerner - - - - -	156.71
Mosles - - - - -	108.23	Hegar - - - - -	161.96
L. Vogel - - - - -	123.52	Beneke - - - - -	162.12
Bischoff - - - - -	134.32	Genth - - - - -	173.23
		Mean - - - - - -	126.76
		Corresponding to Chloride of Sodium -	210.0

This for 1,000,000 of men per year gives 4,888.3 tons, at ½*d.* per lb., or 92*s.* per ton; has a value of 22,486*l.*

TABLE X.

AVERAGE Quantity of AMMONIA discharged by Adult Healthy Men in 24 Hours.

OBSERVERS.	Amount in Grains.	
Neubauer - - - - -	12.8	Mean of 12 experiments upon a man æt. 30; man æt. 20.
The same - - - - -	9.5	
Boecker - - - - -	6.48	
Kerner - - - - -	12.8	
Mean - - - -	10.52	

TABLE XI.

AVERAGE Amount of POTASH in Urine of Healthy Men.

One Man discharges, on an average, 58.2 grains of Potash in 24 Hours.

OBSERVERS.	Quantity in Grains.	
Berquerel - - - - -	26.36	This is probably too low, from mode of analysis employing by which is volatilised.
Genth - - - - -	107.77	
Boecker - - - - -	40.5	
Mean - - - -	58.2	

One million men will therefore yield per year, 1,354.7 tons; value, at 32 *l.* per ton, 43,350 *l.*

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TABLE XII.

AVERAGE Amount of LIME and MAGNESIA in the Urine of Healthy Adults in 24 Hours.

OBSERVERS.	Grains of Lime.	Grains of Magnesia.
Neubauer	2.90	3.08
Duhrnberg	6.36	4.21
Wagner	2.62	2.66
Genth	2.33	2.53
Mean	3.55	3.12

TABLE XIII.

AVERAGE Quantity and Composition of the URINE of 20 Adult Women between 16 and 40 Years of Age.

OBSERVERS.	INGREDIENTS.	
Berqueril	Water	42 fluid ounces.
Levann	Urea	390.0 grains.
Bischoff	Uric acid	7.3 „
Mosler	Chlorine	98.9 „
Beigel	Sulphuric acid	30.2 „
Ranke	Phosphoric acid	56.2 „
	Extractives, bases, and other ingredients	149.0 „
	TOTAL Solids	731.6 „

TABLE XIV.

AVERAGE Quantity and Composition of URINE of Children of Four Years Two Months of Age, and 31 Pounds Weight.

OBSERVERS.	INGREDIENTS.	
Scherer	Water	23 fluid ounces.
Runmel	Urea	178.8 grains.
Bischoff	Extractives and volatile salts	60.7 „
Levann	Mineral salts	186.9 „
	TOTAL Solids	426.4 „

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Table XIV.—*continued.*

Boys from 3 to 16 Years.

Observer.	No.	Age.	Weight.	Urine.	Urea.	Chloride of Soda.
Rummel Uhle	4	*Yrs.* 3 to 5	30.4 lb. avoirdupois.	26.1 oz. avoirdupois.	216 grains.	123 grains.
Mosler	1	6	34.1	42.6 oz. avoirdupois.	254.6 grains.	101.6 grains.
Scherer	1	7	493.	37.2 oz. avoirdupois.	282.4 grains.	
Mosler	1	11	52.8	61.3 oz.	328.9	163.6
Uhle	1	13	72	26.6 ,,	290.4	
Bischoff	1	16	107.58	26.1 ,,	304.64	135.84

Observer.	No.	Age.	Weight.	Urine.	Urea.	Na.
Girls from 3 to 5:		*Yrs.*	*Lbs.*	*oz.*		
Scherer Rummel Uhle	1 1 1	3 to 5	33	24.9	226.18	106.5
Girls from 15 to 20:						
Mosler	1	16	72.6	56.5	355.12	115.8
Mosler	1	17	101.2	53.9	378.28	148.224
Rummel Uhle	1 1	17 18	131.2	29.4	349.37	125

The quantities of Urine and ingredients discharged by individuals of both sexes below 10 years of age are equal. Children of both sexes under seven years of age excrete almost double the amount of Urea which an equal weight of adults excretes.

Table XV.

Proportion of Urine to Fæces.

Observer.	Urine in Grains	Fæces in Grains.
Valentin	22.363	2.950
Gross	20.519	1·821
Gross	28.455	2.408
Laun	30.880	2.624
Beneke	20.674	1.486 average of 6 days in 3 healthy males.
The same (2d series)	27.375	2.394 average of 6 days in 3 healthy males.
Mean	25.044	2.280

TABLE XVI.

PROPORTION of the URINE of the Inhabitants of London to their FÆCES.

Urine	1,059.151 tons per annum.
Fæces	96.424 „ „

Value of Urine	£.1,030,502.
Value of Fæces, at 1 *l.* 8 *s.* per ton	134,993.

TABLE XVII.

AGES OF THE PEOPLE IN LONDON.

AGES of MALES and FEMALES, enumerated 8 April 1861.

YEARS.	Males.	Females.
All ages	1,307,781	1,496,208
„ Both sexes	2,803,989	
Under 5 years	180,893	181,403
5 years	149,335	150,924
10 „	130,799	133,550
15 „	119,949	139,206
20 „	122,548	154,841
25 „	111,668	140,367
30 „	102,755	122,012
35 „	88,366	102,151
40 years	82,068	93,832
45 „	62,782	71,408
50 „	51,497	61,231
55 „	34,985	43,202
60 „	30,438	40,878
65 „	17,614	25,322
70 „	12,241	18,862
75 „	6,133	10,061
80 „	2,706	4,821
85 „	779	1,615
90 „	183	412
95 „	38	93
100 years and upwards.	4	17

NUMBER of CHILDREN in London at each Year under Five.

YEARS.	Males.	Females.
Under 1 year	42,262	42,229
1 year	35,588	35,704
2 years	35,602	36,092
3 „	34,344	34,379
4 „	33,097	32,999

TABLE XVIII.

ESTIMATE, in round numbers, of Fluid Voidings and valuable ingredients in Adult Males and Females.

IN 24 HOURS.	MALES.	FEMALES.
	Avoirdupois.	
Water (Urine)	52 ozs.	42 ozs.
Urea	500 grains.	400 grains.
Uric Acid	8·5 „	7·3 „
Creatinine	12 „	10 „
Heippuric Acid	19 „	15 „
Phosphoric Acid	50 „	55 „
Sulphuric Acid	32 „	30 „
Chloride of Sodium	210 „	170 „
Ammonia	10 „	8 „
Potash	58 „	48 „
Magnesia	3 „	2 „
Lime	3·5 „	3 „

TABLE XIX.

ESTIMATE, in round numbers, of Fluid Voidings and valuable ingredients of Males and Females below 20 years of age.

		Males and Females.
Age, 3 to 5—Weight, 30 lb.		
Water		25 oz.
Urea		200 grains.
Other Organic and Mineral Solids		225 „
Age, 5 to 10—Weight, 41·7 lb.		
Water		40 oz.
Urea		270 grains.
Other Organic and Mineral Solids		300 „
		Males.
Age, 10 to 15—Weight, 62·4 lb.		
Water		44 oz.
Urea		310 grains.
Chloride of Sodium		160 „
Age, 15 to 20—Weight, 103 lb.	Males.	Females.
Water	26 oz. (One obser. only.)	46 oz.
Urea	305 grains.	360 grains.
Chloride of Sodium	136 „	130 „

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TABLE XX.

THE POPULATION of LONDON calculated as Adult MALES.

Total Souls, 2,803,989.

Males above 20 and below 60	656,669
Females above 20 and below 60	790,044
The fluid voiding of one female between 20 and 60, to the voiding of one male between 20 and 60, is as four to five $\frac{790,044}{5}$ × = 4 males	632,035
The fluid voidings of 790,044 females, are equal to the fluid voidings of 632,035 males.	
Of the 84,491 children under one year, about one quarter will contribute eight ounces of urine per day. The rest will be lost. The amount collected will scarcely make up for the loss incurred through children one year and under two years of age. This class comprises 71,292 souls. Deducting probable losses, five children may be estimated to furnish the value of one adult male, 71,292 × = 5 adult males	14,258
The children two years and under three number 71,694, and may be computed to furnish value in the proportion of four to one adult male, 71,694 × = 4 adult males	17,923
Of children three years and under five years of age, 134,819 are living in London. Their fluid voidings may be computed to equal those of half their number, or 67,409 adult females, and these represent the value of $\frac{67,409}{5}$ × 4 adult males	53,924
Of individuals of both sexes, from five years upwards and under 10 years of age, there are living in London 300,259. Every two of these excrete valuable matter equal to one adult male. This represents a contingent of adult males	150,129
Of individuals of both sexes, aged 10 years and under 15, there are 264,349 living in London. The excretion of every five of these may be estimated as equal to that of three adult males. This amounts to the produce of adult males	158,607
During the years from 15 to 20, the amount of valuable matter voided becomes larger, to the amount probably of one-seventh, in females than in males. Taking the average discharge of valuable matter in an individual in this category to be seven-tenths of that of an adult, then the 259,155 living in London excrete as much as $\frac{259,155}{10}$ × 7 adults =	181,405
Between the age of 60 and 70 the quantity of valuable excrete falls 10 per cent. below those of middle aged persons.	
Of the 48,052 males of that age living in London, 4,805 will have to be deducted, leaving adult males	43,247
Of females of the same age, 60 to 70, there are living in London 66,200. From these for the same reason 10 per cent. have to be deducted, leaving 59,580 middle aged females to be placed into the account, which represents value of $\frac{59,580}{5}$ × 4 adult males	47,664
It may be assumed that in persons between the ages of 70 and 80, the quantity of valuable matter excreted in the renal fluids falls 20 per cent. below that of middle aged adults. The 18,374 males of these ages living in London represent therefore middle aged males	14,700
The 28,923 females of between 70 and 80 represent 23,139 females of middle age, which $\frac{23,139}{5}$ × 4 male adults	18,508
It may further be assumed that in people of from 80 to 100 years of age the quantity of valuable matter excreted in the urine falls 30 per cent. below that of middle age. Of males between 80 and 100 and upwards, there are living in London 3,710, which (minus 1,113) leaves middle aged adults	2,597
The 6,958 females between 80 and 100 and upwards, represent (—30 per cent. 2,085) 4,873 middle aged females. These in their turn represent $\frac{4,873}{5}$ × 4 middle aged males	3,896

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Table XXI.

The Population of London Calculated as Adult Males.

Summary.

1 year and under 2 equal to adult males	14,258
2 ,, ,, 3 ,, ,,	17,923
3 ,, ,, 5 ,, ,,	53,924
5 ,, ,, 10 ,, ,,	150,129
10 ,, ,, 15 ,, ,,	158,607
15 ,, ,, 20 ,, ,,	181,405
20 ,, ,, 60 males	656,669
20 ,, ,, 60 females equal to males	632,035
60 ,, ,, 70 males equal to middle aged	43,247
60 ,, ,, 70 females equal to males	47,664
70 ,, ,, 80 males ,, ,,	14,700
70 ,, ,, 80 females ,, ,,	18,508
80 ,, ,, 100 males ,, ,,	2,597
80 ,, ,, 100 females ,, ,,	3,896
	1,995,562

Taking into account that there are many thousand persons who come to London during the day, but sleep without (and are not enumerated as living within) the metropolitan district, and deposit a portion of their fluid excretion in town; also many thousands of casual visitors. Taking further into account the rapid increase of London, we are justified, I think, in assuming that the population of London excretes an amount of urine and valuable ingredients equal to that of 2,000,000 adult or middle aged males.

Table XXII.

Fluid Voidings of the Population of London, calculated as 2,000,000 Adult Males.

1 per day.

		£.	s.	d.
Urine, 650,000 gallons, or 2,901 tons, 176 gallons.				
Ammonia from Urea, 36 tons (3,608), at 60 *l.* per ton	value	2,160	–	–
Ditto from its salt, 1·27 tons	,,	76	4	–
Ditto - Uric acid.				
Ditto - Creatinine.				
Ditto other nitrogenized matters.				
Phosphoric acid.				
Sulphuric acid, 4,081 tons	,,	37	6	–
Chloride of sodium.				
Potash.				
Lime - } Magnesia } 1,714 lbs.				

Table XXIII.

Amount and Value of Fluid Voidings of the Population of London, calculated at 2,000,000 Adult Males. Per Annum.

		£.	s.	d.
Urine, 237,250,000 gallons, or 1,059,151 tons, 176 gallons.				
Ammonia from Urea, 13,140 tons, at 60 *l.* per ton		788,400	–	–
Ditto from its salts, 465·5 tons	value	27,930	–	–
Ditto - Uric acid, 160·8 tons	,,	9,648	–	–
Ditto - Creatinine, 251·8 tons	,,	15,108	–	–
Ditto other nitrogenous matters, 200 tons	,,	12,000	–	–
Phosphoric acid, 2,271.8 tons, value at 1½ *d.* per lb., or 14 *l.* per ton		31,805	14	–
Sulphuric acid, 1,489·5 tons, value at 1 *d.* per lb., or 9 *l.* 6 *s.* 8 *d.* per ton		13,614	10	–
Chloride of sodium, 9,776·6 tons, value at ½ *d.* per lb., or 4 *l.* 12 *s.* per ton		44,972	–	–
Potash, 2,709·4 tons, value at 32 *l.* per ton		86,700	–	–
Lime - } Magnesia } 625,610 lbs. at ⅛ *d.* per lb.		325	16	9

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TABLE XXIV.

ANNUAL VALUE of the Fluid Voidings of the Population of London.

SUMMARY.

		£.	s.	d.
Ammonia	from Urea	788,400	–	–
	„ Ammoniacal salts	27,930	–	–
	„ Uric acid	9,648	–	–
	„ Creatinine	15,108	–	–
	„ Other nitrogenized matters	12,000	–	–
Phosphoric acid		31,805	–	–
Sulphuric acid		13,614	–	–
Chloride of sodium		44,972	–	–
Potash		86,700	–	–
Lime Magnesia		325	–	–
	TOTAL - - - £.	1,030,502	–	–

Value of one ton of urine, rather less than 1 *l.*
Value of annual urine of one adult male rather more than 10 *s.*
Two tons per acre would give one gallon for every nine square yards.

Four tons per acre would be equal to the ordinary manuring with guano. The million tons would be sufficient to manure 250,000 acres of arable land to the extent of making them bear good wheat crops every year.

TABLE XXV.

COMMERCIAL Prices of Articles contained in, or obtainable from, Human Excretions, January 1863.

	£.	s.	d.		£.	s.	d.	
Nitrate of potash	40	–	–	to	45	–	–	per ton.
Average of same for many years	30	–	–	to	35	–	–	„
Nitrate of soda	13	–	–					„
Ammonia, sulphate from gas works	13	–	–	to	14	–	–	„
Ditto carbonate	40	–	–					„
Potash, carbonate	30	–	–	to	32	–	–	„
Lowest price ever known	20	–	–					„
Salt, common	4	12	–					„

TABLE XXVI.

PRICES in January 1863, of Guano, Superphosphate, and Linseed Cake.

		£.	s.	d.		£.	s.	d.
Peruvian		13	7	6	to	14	5	-
Phosphate of Lime, ¾ *d.* per lb. Nesbitt, p. 37 Phosphoric acid, 1½ *d.* per lb.	Literary estimates.							
Superphosphate of lime, 30 °/₀ of Townsend's soluble and insoluble phosphates		5	5	0	per ton.			
Dissolved bones, 30 °/₀ of ditto.								
Ditto		6	15	0				
Gypsum, per ton		1	–	–	to	1	8	0
Linseed cakes.								
American	1863	9	–	–	1862	11	10	–
English		10	–	–		10	10	–

18 Upper Grosvenor-street, 7 May 1863.

Mr. Chairman and Gentlemen,

As a humble individual I throw myself on your kind indulgence, for a perusal of the accompanying plan for the utilising of the sewage of the metropolis. I am not in a position to offer a tender for the working of it, that is not my object. I wish to show by this plan, that the sewage of London can be turned to a strong fertilising manure useable on all lands. This plan is to separate the heavy and thick material from the thin and watery, as much as possible; the thick to be converted into a solid manure; the thin to be used on the lands adjoining the banks of the river.

The thick part of the sewage can be converted into manure of the consistency of mortar, by mixing with it different dry materials, such as lime, soot, bone dust, wood ashes, charcoal, sawdust and salt (which can be mixed with it when being used, as with guano). These ingredients will absorb a large quantity of the best and strongest of the sewage; and thus a manure will be prepared suitable for any kind of land, and which could be used either dry or as a liquid. If the farmer wants it in a liquid state, let him put a given quantity of the dry manure into an irrigating cart (made for the purpose, with a rotary fan), and upon this pump a sufficient quantity of old rain water, assuming that he has collected this from his premises, and the manure will be ready for immediate application.

Then, as to the thin part of the sewage, I propose to pump it from the reservoir into floating tanks, fitted with powerful pumps, and in these float it up and down the Thames with the tide, so that it may be at once obtainable by the farmers on the banks of the river; who would, I think, be glad to get a supply at a cheap rate, and they might obtain it by contract at a cheap rate, if each of them provided his own tanks, with which to reserve a supply on his land; thus being able to use little or much as he may require.

If the thin portion of the sewage is to be allowed to pass into the Thames, it will be necessary to use the filter; by my plan no filtration will be required.

The works should be as many feet below the fall of the main sewer as to allow of the above proposition being carried out.

If the sewage of London can thus be made useful, the plan will as well apply to every city and town throughout the kingdom. And instead of having polluted rivers that spread disease along their courses, health, comfort, and plenty will be diffused through many a district.

I am, &c.
(signed) *David Curwood.*

To the Metropolitan Board
of Works.

Sir, Spring Gardens, 9 July 1863.

On behalf of Viscount Torrington, Mr. Thornton Hunt, and Sir Charles Fox, who act herein under the advice of several gentlemen whose names do not appear in the enclosure, I beg to hand you the accompanying letter, signed by the hereinbefore named gentlemen, begging you to submit it to your Board, and asking them, through you, to give the matter their kind consideration.

I am, &c.
(signed) *Wilson Moore.*

To the Clerk of the Board of Works,
Spring Gardens, S.W.

8, New-street, Spring-gardens,
Gentlemen, 6 July 1863.

After a careful consideration of your advertisement for the disposal of the sewage of the Metropolis, we regret to find ourselves, though anxious to do so, unable to comply with its conditions.

We may, indeed, confidently state that the more the details of any really practical scheme are investigated the more difficult does such compliance become. It is obvious that, in a document whose contents must become public, we cannot explain the precise nature of our intended operations; but it will readily be understood that a public notification of the extent and situation of the land required for such an undertaking would seriously impede any negotiations for its acquisition.

Although we believe the amount required has been exaggerated, and that from 30,000 to 40,000 acres will be found sufficient, still the purchase of such an area, within a reasonable distance of the points of discharge, could not be negotiated with advantage when such complete publicity as your advertisement infers had been given to the transaction.

For these and other reasons we desire to discuss the matter with your Main Drainage Committee, and should be prepared to submit two propositions to them for their consideration, both being based on the assumption that the Board would lease the sewage to us for a certain term, renewable or terminable on certain conditions; on the other hand, we undertaking to construct all the necessary works, to purchase or lease the requisite lands, and to defray all working expenses.

By the one proposition, we should offer to pay the Board a certain percentage of our profit, after deducting interest of capital and working expenses; by the other, we should propose to leave our rent, or royalty, to be determined by an arbitrator appointed by the Board of Trade.

We shall further be willing to enter into a provisional agreement, defining our interests and liabilities, and engaging to deposit plans and take all other necessary steps for prosecuting a Bill in Parliament during the ensuing Session. We should, of course, undertake to demonstrate our financial power to accomplish our undertaking, and should consent to be bound to hold the Board harmless in any proceedings arising out of our operations.

We are, &c.
(signed) *Torrington.*
Charles Fox.
Thornton Hunt.

To the Commissioners of
the Metropolitan Board of Works,
Spring-gardens, S.W.

The Best Mode of Arranging the Drainage of the Metropolis in order to apply the Sewage as Manure to Agricultural Purposes.

1st. Intercept the sewage of the higher portions of the metropolis by a sewer on each side of the Thames, at an elevation in the middle of each of at least 100 feet above high water, and with a declination towards each end of four feet per mile to secure self cleansing; their contents should be available for irrigation of land by gravitation at the respective ends of both. And should there be any doubt as to its continued consumption

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consumption by the agriculturists, stations for deodorising would be available on the banks of the Brent, Lea, Wandle, and Ravensbourne.

These sewers would require to be only one half of the size that such would have to be, if made to convey the sewage from one end to the other in one direction.

2d. The lower portions of the metropolis should be divided into sections in accordance with the watershed of the natural streams which intersect it, and the sewage intercepted from these streams so that they might continue to convey the land and spring waters into the Thames as their natural outlets.

The intercepted sewage which flows from the houses and streets in the higher portions would be received by the upper intercepting sewers, and conveyed to the land by gravitation, while that below would be conveyed in separate conduits to the outlets at the river where pumping power should be provided to transmit this sewage through pipes to lands in the country of such elevations as to be available for irrigation by gravitation. As the first washings of the houses and streets by rain are of equal value to the ordinary sewage, all these appliances should be of sufficient extent to convey such along with the sewage, leaving the storm waters to flow through their natural outlets.

The operations of irrigation being continuous during the whole of the year, they preclude the necessity of reservoirs or any other expensive appliances whatever, and the pressure under which the sewage would be so transmitted to the elevated lands makes it available by tap and hose for any occupiers of land in the intermediate distances.

In consequence of the greatly enhanced value of land by the application of sewage, the agriculturists are very desirous to obtain it, which will secure its continued consumption; and by the above means (it being absorbed by the soil in a flowing state, within six hours after leaving the houses), no decomposition can take place to generate any foul gas whatever.

By these means, the principal part of the sewage can be transmitted westward, so as to flow through the soil purified into the Thames; thus improving its navigation, by supplying it with a greater quantity of water than is taken from it to supply the Metropolis.

The pumping power being placed at the respective natural outlets, would enable the interior drainage, when thus in shorter lengths, to be improved with a greater fall, to secure the whole to be self-cleansing; consequently, no deposits taking place, which at present generate the foul air so much complained of, the expenses for cleansing would be saved.

The pumping power being thus placed would also be available in the low districts during the fall of storm water, to pump such into the Thames and prevent these low districts from the inundations to which they are at present subject on such occasions.

These arrangements would enable the works to be limited to the present requirements, and so completed as any addition or extension of the town, in any direction, could be provided for as additional sections on the more elevated ground, by another more elevated intercepting sewer suitable for irrigation, in a similar manner and on the lower grounds, by making available similar sectional arrangements; thus precluding the necessity of any outlay at present, beyond the present requirements.

Under all circumstances, steam power would be available for pumping and transmitting the sewage from the low districts to the land, and the return therefrom would be ample to bear the expense to be incurred by the proposed arrangements; but should the Conservators of the Thames allow of current water wheels to be adopted, and the embankment to be effected, their substitution for steam power would effect an annual saving more than sufficient to liquidate the whole cost of the embankment, and the current of the Thames might be made available as a motive power for such purpose, without any detriment to the navigation, and also contribute, with pneumatic arrangements, towards improving the ventilation of the sewers.

By dividing the Metropolis into sections for the purpose of effecting its most perfect drainage and the utilisation of the sewage, the works of the respective sections might be commenced and progress simultaneously, and be completed with little or no risk to life or property, and in one-fourth of the time that such an extent of work could be completed, if it were so connected as to form one extensive undivided plan. These sections would also have the advantage of any one of them being available for repairs without interfering with the others; whereas, in one extensive-connected work the repairs of one portion might stop the working of the other portions. All the foregoing are important advantages attainable by the system of sections, but the risk and dangers thereby avoided are of much greater importance, being incalculable as to the construction of the low level intercepting sewers, all professional men representing them as being extremely so, and some of the greatest experience representing them as being impracticable. The Metropolitan Board of Works being unable to enter upon commercial matters, and being compelled to transmit the sewage clear of the Metropolis, and the sea being their only available outlet, they, therefore, grappled with the difficulty and decided upon the construction of works to send it there, however dangerous and expensive they might be. The formation of the Liquid Manure Company, as a commercial medium between the Board and the agriculturalists by securing a remunerative outlet for the sewage on the land, enables the Board so to arrange their works as not only to avoid the risk and dangers they had to contend with, but also to obtain a return for the necessary outlay adequate to liquidate the same.

The works in accordance with the foregoing arrangements, including the most complete embankment of the Thames, can be effected within the cost of 3,000,000 *l.* sterling, the details of which can be entered into with the engineers who have the data necessary for the calculations to form a particular estimate. The returns obtainable from such outlay are also capable of proof from duly recognised existing data.

As the engineers have proposed that the north upper level intercepting sewer be the first portion of the main drainage works to be commenced with, should the Board so decide and direct the same to be constructed so as to convey the sewage to the land as herein suggested, which is evidently the most economical mode of construction, I shall be enabled to secure to the Board a rental for the sewage so conveyed equal in amount to 4 per cent on the cost thereof, commencing on its completion.

John Jas. Moore,
Scientific and Practical Agriculturist
and Agricultural Engineer.
6, Pump Court, Temple,
August 10, 1858.

Metropolitan Board of Works,
11th August, 1858.

Sir,—The Chairman has directed me to acknowledge your communication of the 10th inst.

I am, &c.
J. J. Moore, Esq. *E. Cresy.*

6, Pump Court, Temple,
Sept. 24, 1858.

Gentlemen,—Being deeply sensible of the loss to be sustained by the transmission of the sewage of the Metropolis to the sea, which is the only outlet presented to the Board after its interception from the Thames, and being practically conversant with the application of sewage and its great value to the land in a liquid state during a period of 30 years, I have been induced to ascertain if land is available for its application; the result of which has proved that land to the extent necessary for the use of the whole of the sewage of the Metropolis in favourable localities is available, and I am prepared to lay before the Board engagements on the part of occupiers of land sufficient to consume the sewage continuously, that will be transmitted by the Upper Level Intercepting Sewer which the Board proposes first to construct, provided such sewer be so accommodated as to be available for such land.

I have, &c.
(signed) *John Jas. Moore,*
Agricultural Engineer.
To the Metropolitan Board of Works.

Metropolitan Board of Works,
Sir, 28 September, 1858.

The Chairman has directed me to inform you, in reply to your communication of the 24th inst., that several suggestions similar in character have already been submitted to the Board hitherto without any practical result, and he fears that the Board would hardly feel disposed to entertain a proposition involving an alteration in the Upper High Level Sewer which they propose to construct.

I am, &c.
J. J. Moore, Esq. (signed) *E. Cresy.*

6, Pump-court, Temple,
Sir, 9 October, 1858.

On the 24th ultimo I addressed the Board, intimating that "engagements on the part of occupiers of land sufficient to consume the sewage continuously that will be transmitted by the Upper Level Intercepting Sewer, which the Board proposes first to construct, provided such sewer be so accommodated as to be available for such land," and have since attended two weekly meetings of the Board, in the expectation that the subject would have been brought under their consideration, but the only notice that has been taken of my communication is a note in reply, purporting to be by the direction of the Chairman, and referring to similar suggestions, with the expression of "fears that the Board would hardly feel disposed to entertain a proposition involving an alteration in the Upper High Level Sewer which they propose to construct."

On the last occasion, when the Board decided upon the intercepting system of sewers, as recommended by Messrs. Hawksley, Bidder, and Bazalgette, it was distinctly stated by the member, (Mr. Carpmael) who moved for its adoption, "that it was the principle of interception which the Board were expected to decide upon, and not the particular detail thereof, which might be so modified as to embrace the most favourable circumstance that might occur;" hence, I am induced to think that the fears expressed may be dissipated by the great advantages to all parties which can be attained by the modification suggested, and, therefore, most respectfully request that the subject be brought under the consideration of the Board at the earliest available opportunity, and,

Have the honour, &c.
(signed) *John James Moore,*
The Chairman of Agricultural Engineer.
the Metropolitan Board of Works.

Metropolitan Board of Works,
11 October 1858.

Sir, — The Chairman has directed me to inform you, in reply to your communication of 9th instant, that the Board have already so far approved the Upper High Level Intercepting Sewer as to direct their engineer to prepare the preliminary drawings and specifications, previous to ordering that advertisements should issue for tenders; and upon stating to the Board, at a recent meeting, that he had received a great number of plans and suggestions, some of them similar in character to your own, they did not consider it necessary to enter upon their consideration. It is, however, open to you to bring your proposals before the Board by embodying a statement of your plan in a memorial, and placing it in the hands of a member for presentation.

I am, &c.
(signed) *E. Cresy.*
J. J. Moore, Esq.

To the Metropolitan Board of Works.

The Memorial of *John James Moore,* Agricultural Engineer.

Showeth, — That your memorialist, having been practically conversant with the advantageous effects of the application of manure in a liquid state during a period of 20 years, was solicited in 1845 by an association formed by the late Mr. John Martin, in the Metropolis, to undertake, along with the late Mr. James Smith, of Deanston, measures for a similar application of its sewage; and after the subject, with its facts, had been duly tested by the most eminent men of science of that day, Acts of Parliament were obtained to carry out the same. But, on the measures coming under the control of a Board of Directors, not practically conversant with the subject, who adopted proceedings which were certain to be destructive to the object, your memorialist and his colleague protested against them, and withdrew from the responsibility thereof, and the result has proved as foreseen.

That your memorialist has continued to investigate the numerous projects which have been brought forward to effect the complete drainage of the Metropolis, and duly appreciating the value of the sewage to the agriculturists, he has given particular attention to those which proposed to consolidate the sewage into manure; and being convinced from practical results that such projects were not founded on correct principles, he has invariably deprecated them to prevent the authorities from being misled by these fallacious theories, and although they have uniformly proved so to the extent tested, it is to be regretted that they are still referred to as an ulterior resource for utilising the sewage.

That your memorialist has given particular attention to the proceedings of the Board, and the great difficulties with which it has been surrounded, being constituted by Act of Parliament specially to drain the Metropolis, and prevent the sewage flowing into the Thames, there appeared to them no other outlet for it but the sea, which left the Board no other alternative but to direct works to be constructed for its transmission towards this receptacle; notwithstanding the great difficulties which have to be overcome in their construction —difficulties which engineers of the greatest eminence state to be impracticable — yet the Board appear to have no alternative but to attempt their construction, however difficult and expensive they may prove to be.

That the transmission of the sewage to the sea would be the wasting of a material which is admitted to be worth one million sterling annually, and which is so much required by the agriculturists as to cause vessels to be sent to the most distant countries to obtain a substitute, at considerable expense, and such waste would be highly discreditable to Britain, while the inhabitants of every town on the Continent are deriving a pecuniary return for a similar material, instead of which the proposed works would subject the inhabitants of the Metropolis to heavy rates to liquidate their cost without any pecuniary return whatever being derived therefrom.

That your memorialist has repeatedly solicited the attention of the Board to these facts without their having obtained the attention they so justly merit, and conceiving that the immense number of plans, founded on theory only, which have been laid before the Board, have prevented the due consideration of those that are founded on well authenticated facts and results, he is induced, under all these circumstances, again to solicit the attention of the Board to the utilisation of the sewage in such a manner as will not only avoid the extreme difficulties their proposed works have to encounter, but also secure a pecuniary return towards the liquidation of the expenses necessary for the drainage with such utilisation.

In order to effect these objects, your memorialist suggested to—"Intercept the sewage of the higher portions of the metropolis by a sewer on each side of the Thames, at an elevation in the middle of each of at least 100 feet above high water, and with a declination towards each end of four feet per mile, to secure self cleansing; their contents should be available for irrigation of land by gravitation at the respective ends of both. And should there be any doubt as to its continued consumption by the agriculturists, stations for deodorising would be available on the banks of the Brent, Lea, Wandle, and Ravensbourn. These sewers would require to be only one half of the size that such would have to be if made to convey the sewage from one end to the other in one direction. The operations of irrigation being continued during the whole year, they preclude the necessity of reservoirs or any other expensive appliances whatever."

"In consequence of the greatly enhanced value of land by the application of sewage, the agriculturists are very desirous to obtain it, which will secure its continued consumption, and by the above means, it being absorbed by the soil in a flowing state within six hours after leaving the houses, no decomposition can take place to generate any foul gas whatever."

Since handing the communication to the Chairman of the Board, of which the foregoing quotation forms a part, and which also embraces the utilisation of all the sewage in such a manner as to avoid the great difficulties involved in the works entertained by the Board, your memorialist, in order to remove all doubts as to the land being an available outlet, and as to the disposition of its occupants for the reception of the sewage, called upon them and obtained their written engagements to receive and consume the sewage continuously as manure in a liquid state, to the extent that can be conveyed by the North Upper Level Sewer, and on such terms as will secure a rental to the Board equal to 4 per cent. on the cost of conveying it by gravitation; and at the same time ascertained that a large district of many square miles in extent is available as a natural filter bed of several feet deep of gravel, capable of absorbing any quantity of sewage that might be so applied to it.

Therefore, your memorialist, conceiving that the pecuniary interest of not only the occupiers of land, but that also of the ratepayers of the Metropolis is deeply involved in the subject, most respectfully solicits that the Board will be pleased to take the foregoing facts into consideration, and direct the North Upper Level Intercepting Sewer to be constructed in such a manner as will be available to supply the occupiers of lands with sewage by gravitation, instead of conveying it to Barking Creek, where it cannot be so available for agricultural purposes.

John Jas Moore,
Agricultural Engineer.

6 Pump-court, Temple,
October 20 1858.

FACTS and Results illustrative of the foregoing Arrangements.

NOTWITHSTANDING the unfavourable opinions of analytical chemists as to consolidating the sewage into manure, and the disappointment of every attempt to effect the same, the Board have resolved to obtain the services of chemists of eminence again to investigate the subject. Under these circumstances it may be advisable, in order to prevent any misconception that may tend to mislead them, to give a particular detail of such results as prove that, however advantageous the investigation of certain materials by the chemist in his laboratory may be, the effects thus produced even by those who stand at the head of the profession differ widely from the results produced in the great laboratory of Nature, particularly in respect of the vegetable kingdom. As a very remarkable instance of this nature, some years ago Professor Liebeg visited this country, and made a tour of some months among its agriculturists to obtain a knowledge of their operations and the results thereof; after which, conceiving that he had mastered the subject, he, along with his friend Dr. Musprat, who stands high as a manufacturing chemist, took out a patent for the manufacture of manure, which coming forth from professors of such eminence, it was expected that such manure would prove to be of great advantage to the agriculturist; but upon being tested it proved to be of no value whatever as "manure," or, in other words more definite than the term "manure," as "food ready prepared for the vegetable kingdom." Then, again, in all the various reports made by analytical chemists of the numerous analyses of consolidated sewage, although they profess to define the quantity of each constituent contained in such consolidated compound and place a value on the same as manure, according to the market value of the various constituents, yet they all overlook the fact that no member of the vegetable kingdom can take up as "food" any crude matter whatever, but that its food must be in a state of chemical solution, either in a gaseous form or in water, and that the various fertilising substances which were held in solution by the sewage when precipitated therefrom, by the application of any other material to which they had a greater affinity than they had for water, necessarily became insoluble, and in such a state inapplicable as "manure" or "food for plants." Hence, although these respective constituents, when separated from the compound of consolidated sewage in the laboratory of the chemist, may be of the marketable value placed upon them even as a manure, but in their united state forming the insoluble compound, such is not in the condition necessary as "food for plants," and, therefore, in that state, valueless as "manure." These facts not being attended to has led to expectations respecting such consolidation that have hitherto and must necessarily result in disappointment: every attempt to effect any object by adopting means opposed to the laws established by Infinite Wisdom must so terminate. This has proved to be so after all the sanguine and flaming reports published respecting the attempts, at considerable cost, to consolidate the sewage at Leicester, with the same result at Tottenham and Puddledock, the compound produced at these places not being so valuable as the lime used for its precipitation; which must necessarily be the consequence, as the lime itself, having a great affinity for the carbonaceous matter in the sewage, becomes carbonate of lime, and as such insoluble, therefore not available as "manure," neither had it precipitated much of the valuable fertilising materials from the sewage. Even at Paris, by the application of sulphate of lime to precipitate the fertilising materials contained in waterclosets, only about 20 per cent. of these materials were thus obtained.

The advocates for the consolidation of the sewage must admit these principles to be founded on practical results, but may contend, that "Although the consolidated sewage is insoluble, yet it is capable of decomposition and becoming soluble, as a large portion of farmyard manure, when applied to the land, is in an insoluble state, yet ultimately becomes soluble by decomposition in the soil, and feeds the crops growing thereon." It is admitted that such is the case respecting farmyard manure, which is a compound of soluble and insoluble materials, the soluble being food ready prepared for the crop, and the insoluble becomes so by decomposition in the soil; but these insoluble materials are not only tending naturally to a state of decomposition, but the most of them are in the incipient state when so applied; whereas the consolidated sewage has been forcibly transformed by art from such a state, hence, not naturally so disposed: but even its capability of decomposition requires further means and time to effect it, both of which are attended by a sacrifice of funds; the whole of which, as well as those incurred in its consolidation, are saved by the application of the sewage in a liquid state, the advantages of such application not being limited to the intrinsic value of what is generally designated "manure," but extending considerably to the vehicle (water) in which it is transmitted to the soil, both as to its own inherent power to effect its transmission to the soil and its great facility of application during the various stages of the growth of the produce thereof, and at the same time forming extensively a necessary constituent of every member of the vegetable kingdom, and without which no manure whatever is available as their food. These being incontrovertible facts, it may be asked, Is it consistent with sound judgment to attempt to change these immense advantages, which are established by immutable laws, by adopting a system in opposition thereto and impracticable? A very great misconception exists respecting the value of the crude materials held in suspension by the sewage water: some persons imagine that these when deposited by the liquid are valuable as manure, whereas it is known, from the experience of many years, that such materials are not worth the expenses of transit to the nearest land available for their application. Even at Edinburgh, from deficiency of water in 1846, the sewage, being so thick with suspended substances, before its application to the grass-land had to be passed through tanks in which these substances were deposited. Such deposit, although black and rich in appearance, proved to be not worth the expense of removal to the land; and upon due investigation of the operations and principles involved in its production, no other conclusion could be arrived at; the whole of the materials having been triturated by flowing from the houses, and the soluble portion absorbed by the water, leaving only the insoluble materials as a deposit. Similar misconceptions exist respecting the mud on the banks of the Thames, which, from its black appearance, is represented even by chemists to possess very valuable fertilising qualities, and that its decomposition produces the very offensive effluvia so much complained of during warm weather; whereas neither of these opinions, imbibed from appearances only, has any real foundation whatever, the latter having been fully tested during the investigation by the Committee on Mr. Gurney's plan in the warmest weather, and when the application of lime was ordered for its suppression. Evidence on the subject was tendered to the Committee, but declined. The water of the Thames was at the same time accused of generating the obnoxious smell which then existed, and that to so great an extent, particularly in and about the Houses of Parliament, as to induce precipitancy

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precipitancy of legislation in order to close the business and afford the Members an opportunity to escape from it.

The testing of these two subjects, at that time so much abused for the effect produced on the olfactory nerves, was effected in the following most simple and conclusive manner, by a person who, from many years' experience, had been convinced of the fallacy of the opinions then formed. He took a gentleman who was strongly imbued with these opinions along the banks of the river to the Temple Pier, which projects far therein, and inquired of the two men who attended the passengers if they felt any unpleasant smell there. They replied that they did, more particularly when the steamboats were passing, as they stirred up the water with their paddles; and when these men were asked what was it that smelled so badly, they immediately pointed to the water and said, "Of course it is that black stuff; can't you see it? On a doubt being expressed as to the water producing the smell, a bucketful of it was taken up on the pier, and no smell whatever could be felt from it by any one of the four persons present, after repeatedly trying by placing their noses close to the water in the bucket; on which the men expressed great surprise, and inquired," "From whence then came the smell"?—thus verifying the declaration of Sir William Cubitt, that "no man ever felt any smell of the water of the Thames." On the following day lime was brought to the pier at Westminster Bridge to destroy the smell that was said arose from the large quantity of black mud deposited near there, and a similar investigation took place by the same person at low-water, as to that material. The men employed for the liming process were equally positive that the smell there was produced by the black mud as the men at the pier were—that the smell they had felt there was produced by the water of the Thames; but on being induced to obtain some shovelsful of the mud, which had the most obnoxious appearance, they all admitted, after repeated trials, that they could not feel any smell whatever from it, not even so much as the earthy smell felt when digging a field or garden. This being contrary to the opinion given by Mr. Gurney to the Committee, it is necessary to show how he came to form such an opinion, as he evidently was sincere in adducing it as the conviction on his own mind. He had obtained a chemical analysis of a portion of this mud, which is a compound of various materials, including the strongly antiseptic black material carbon, which has a powerful effect in preventing decomposition; but in the analytical operation it of course became separated from other constituents which had a tendency to decomposition, thus generating the smell, which not only deceived himself respecting the effects of the original compound, but also the Committee before whom the constituents were adduced in support of his opinion.

A similar misconception exists respecting deodorising the sewage by the application of lime, imagining that because the lime separates the dark colouring and suspended matter from the sewage, that the greater transparency of the liquid was an indication of the removal of all tendency to decomposition; whereas quite the contrary is the fact, as the principal material abstracted by the lime is the dark carbonaceous matter, which has the most powerful effect in preventing decomposition, and which, after its abstraction, the liquid is more susceptible thereof; and which fact became developed to the Committee in the bottle of each, which had stood during several days on their table, and remarked upon as such by the Chairman, who stated that the bottle containing the comparatively clear deodorised liquid produced a more obnoxious smell than that contained in the bottle without any attempt at deodorisation. It may be asked, if this is really the case, how are the results at Leicester respecting the apparent satisfactory state of the deodorised liquid there to be accounted for? This is easily answered: the sewage there had been to a certain extent stagnant, and not flowing away freely, which caused it to decompose and become obnoxious when Mr. Wicksteed undertook to manufacture it by the application of lime into solid "manure" as a profitable speculation, at the same time professing to deodorise the water. For these purposes he had to construct engines and pumps to raise the sewage to a certain elevation, from which, after the lime extracts the colouring matter, the water flows in a comparatively clear state, and having a sufficient declination, continues to flow commingled with other water so as to prevent decomposition. The same would have been the case with the sewage if it had been so placed and continued in motion to the same extent, although it would not have been so pleasant to the eye; neither would it have induced the return of trout to the river, as stated to be the case at present, carbonaceous matter when inhaled in certain quantities being very prejudicial to animal life. Some persons are so deceived by appearances as to imagine, when they see the most fertilising liquid flow away from our towns, and after passing on a few miles it becomes so clear and transparent as pure water, that the fertilising properties have been destroyed, and useless as food to the vegetable kingdom; practical results, however, prove this to be a fallacy, as neither the clearness of the liquid, nor even chemical analysis, are any true criterion of the value of such a liquid.

As there can be no doubt as to the existence of most obnoxious effluvia in the Metropolis during the period referred to, and the general opinions then entertained of its origin proving to be erroneous, it is of great importance to identify clearly the true cause of such, in order to adopt the means necessary to prevent its recurrence, which is not only repugnant to the olfactory nerves, but also most prejudicial to health.

There appears to be no difference of opinion respecting the substances from which such effluvia originates, but it is in respect to their stages of transit and the operation in such to which they are subjected, that the differences of opinion exist; hence, to arrive at a correct conclusion on the subject, it is necessary that we investigate from the commencement of their transit, and follow them in their respective stages, to ascertain where the evil exists. We find at the commencement that in all the houses connected with the sewers of the metropolis, there is ample supply of water, not only to wash up and carry away all the foul matters necessarily produced in these houses, but also to neutralize their tendency to decomposition while continued in a flowing state, as we find that this liquid, containing these foul matters, will not undergo decomposition until they are retained in a stagnant state for some time, the extent of which, so as to induce decomposition, being dependent on the temperature in which they are placed. We also find that any of the solid matters contained in the sewage which may be deposited during its flowing in the sewers very soon decomposes; hence we arrive at the conclusion that it is the quiescent state of the sewage in a stagnant condition, and the deposits of solid matter contained in it, which decompose and generate the gases that are so obnoxious and so much complained of. These facts were fully established during the investigation of the subject by a Select Committee of the House of Commons in 1846. On that occasion, in order to test the subject, while complaints were made against the noxious smell issuing from gullyholes in the streets, a sewer was opened in Grosvenor-street, and a quantity of the flowing sewage taken from it and applied on the Marquis of Westminster's lawn, at the rate of 140 tons per acre, without any person being able to distinguish it by the smell from pure water, although it visibly contained dark-coloured matter. That Committee having commenced their investigation with unfavourable impressions, even when removed by demonstrative evidence, hesitated to report on the subject until it was examined scientifically by Professors De Labech, Playfair, and Phillips, which proving satisfactory, the Committee reported most favourably on the utilisation of the liquid sewage, stating that it is only by such means "the important purposes of cleansing our towns, purifying our rivers, and enriching our soil can be accomplished."

In accordance with these principles, founded on the facts stated, it is not difficult to define the cause of the noxious smell so much complained of during the warm weather last summer in and about the Houses of Parliament. As the eye became directed to the dark-coloured water of the Thames and the black mud on its banks, when the nose was offended by the existing effluvia, it was quite natural to attribute the smell to these apparently noxious substances; but there was one circumstance connected with it which was irreconcileable to such a conclusion, viz., that it was while the tide was flowing up the river from half-flood to highwater that the smell was most intense, and this fact induced Lord Palmerston, in Committee, to ask Mr. Gurney how he accounted for it; to which he replied—"that the flowing tide stirred up the mud on the banks of the river, which caused the increased intensity of the smell," with which reply his Lordship did not appear well satisfied. And he had good reasons to doubt it, as the natural effect produced by the gradually-flowing tide is not stirring up the mud, but gently covering it with water, which is the great purifier of all organic matter, but which Mr. Gurney attributes to another element (fire), the direct action of which on atmospheric air is quite the contrary of purification, as it abstracts a portion of its oxygen, which is the test of purity in proportion to the quantity contained therein; and although he is engaged in ventilating the Houses of Parliament by fire, and professes to consume the obnoxious gases thereby, it is only while he combines therewith water in a state of vapour or steam that these gases are neutralised, and which appeared from the evidence of his own witness (Mr. Thompson) to be more completely so neutralised by the vapour without the direct action of the fire, which only improves ventilation by causing the ingress of a greater current of fresh air; hence it would be more consistent with established laws to pass impure air and foul gases through water to purify them, as it is well known that rain tends to purify the atmosphere.

During the investigation by the Committee on Mr. Gurney's plan, who proposed to ventilate all the sewers of the metropolis by fire, and thereby consume all the noxious gases they produced, Messrs. Bazalgette and Haywood were examined as to such proposal; and it appearing that they had not personally examined the ventilating system adopted by Mr. Gurney for the Houses of Parliament, the Committee directed that they should personally examine that system when in operation, and the extent of its effects on the sewers surrounding these Houses, and report thereon the following week. After having complied with these directions, these gentlemen stated that they had found one of the sewers connected with the Houses of Parliament nearly filled with deposits, and the most noxious gases issuing therefrom, and that the effects of the system of ventilation in operation in these Houses did not extend far in the sewers connected therewith. Here is evidently the cause of the noxious smell felt by the Members.

At the time that this noxious effluvia was complained of, on and near the Thames, the gullyholes in the streets of the higher parts of the metropolis issued forth gases of much greater pungency to the olfactory nerves even than what was complained of in the lower parts. This is perfectly consistent with the true state of the case, namely, that it is the solid matters deposited in the sewers which by decomposition produces the evil, and that the earlier they are so deposited, before undergoing much trituration in their conveyance by the water, that they not only decompose with greater facility, but produce more volatile and pungent gases, including ammonia; whereas those produced by the deposits in the lower parts contain more carbonic acid gas, which is of greater specific gravity than the atmosphere; consequently flow down the sewers to their outlets in the river, and float on its surface unperceived by the eye, but causing the smell complained of, until they become absorbed by the water, which is facilitated by the action produced by the paddles of the steamboats.

Having thus conclusively identified the causes which produce such injurious effects, our next object should be to adopt the best means for their removal, and in such a manner as to be most effectual and permanent in their operation.

It must be evident that a particular attention to the laws which are established for the government of matter under its various forms is absolutely necessary in order to succeed, and that every deviation from them tends to failure. Upon the most mature investigation of the operation of these laws, we find that all the visible changes which take place in organic matter, indicating decay, or designated destruction by superficial observers, is not destruction, as not a particle of matter has ever yet been destroyed, but a transformation, preparatory to the support of new life, first in the vegetable and ultimately in the animal kingdom — thus sustaining the continued round of duty prescribed for organic matter. In giving particular attention to this prescribed course, we perceive that all the means necessary for its accomplishment are duly provided. The earth is ready for the reception of all substances which, from their changed state, have become not only offensive to our senses, but also injurious to

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to our health, and it is the receptacle best adapted for the prevention of their being so injurious and offensive, and also the only medium through which they can again be transformed into new life; therefore it is not only our privilege, but our imperative duty, to transmit them to this receptacle, otherwise we are in direct opposition to the designs of a beneficent Creator, who even condescended to enjoin that such offensive matters should be immediately placed in the earth; hence duty being invariably the path of safety, our compliance therewith is most certain to be successful. Therefore, we should transmit the injurious and offensive matters produced in the Metropolis to the land in the most expeditious manner that the means available for the purpose will admit of. Water, which is the only means for cleansing, thus forms with these matters sewage, which is not only in the best condition to facilitate its transmission to the land, but also in the state least offensive for the application of such substances, which are so necessary to be used in agriculture. As persons who are not conversant with the various operations of agriculture may not be aware of this fact, a description of the mode adopted in the application of solid manure will be conclusive on the subject. The solid farmyard manure is retained in an exposed receptacle in a state of progressive decomposition, and so conveyed in open vehicles for some distance to the land, upon which it is spread, and so remains on some occasions until the soluble parts are washed into the soil by the rain, and sometimes until it is turned under it by the plough, but always exposed during some time, so that the gases generated by decomposition emanate from it, thus also losing more than half of its fertilising materials; whereas the sewage can be transmitted in a covered flowing state, and absorbed by the soil, within a few hours after it has left the houses; therefore, no decomposition can take place before it becomes so absorbed. Some persons might imagine that sewage applied in irrigating of grass-land may prove injurious to health, but there is not a single instance of such being the case where the liquid has not been allowed to become stagnant, without which no decomposition can take place; and this is easily accounted for. The flowing liquid causes a similar current in the atmosphere pressing upon it, thus obtaining a continual change of atmospheric contact with fresh air, which neutralises all tendency to decomposition, and without which no volatile gases can be generated, neither will any such emanate from it by evaporation. There may have been some cases where due care has not been taken to secure the constant flowing of water used in irrigation, some of which becoming stagnant and containing decomposing vegetable matter produce injurious emanations; therefore, in all works for irrigation, due care should be taken in their construction that no stagnation of the liquid could take place. From the foregoing facts and results it is evident that the object which requires the most particular attention in the drainage of the metropolis, and the transmission of its sewage to its legitimate receptacle (the land), is the proper formation of all the sewers, internal, intercepting, and transmitting, so as to secure their being permanently self-cleansing; as any neglect in this respect cannot be compensated for by any arrangements whatever, however elaborate they might be. The accomplishment of such self-cleansing power would not only remove all the causes of the evils so much complained of, but be ultimately the most economical, by saving the expenses that would otherwise have to be incurred for flushing, cleansing, and ventilation; the cause of the evil being thus removed, neither would then be required. The great difficulty experienced by the referees was their viewing the metropolis and extensively surrounding districts as one inseparable whole, which had to be drained irrespective of its natural conformation, and it is this mistaken view that has presented the difficulties to most persons who have attempted to treat the subject; whereas, although the metropolis is so large, and extended over many square miles of ground, it is, in fact, a congeries of districts, completely isolated for drainage by elevated ridges that gives each a separate and distinct watershed, which to effect complete drainage, with due regard to economy, have to be treated in a certain degree separately and distinctly from each other. As to the power required to pump and transmit the sewage from the lower parts of the metropolis, the natural streams which flow through it from the high ground could, from their altitude, by the use of the pipe, piston, and cylinder, which are available to any extent of altitude, be made to contribute a considerable extent of power for that purpose. Even the flood-water proposed to be intercepted by the high-level sewer on the south side would thus afford ample power to pump and keep the low districts which are subject to inundation from floods, free from such inundation during floods, as the upper ground is more extensive than this lowest part, consequently a greater quantity of rain would fall upon it than the quantity to be pumped from this low ground: the application of this available power would preclude any necessity for the Great Low-level Sewer, and the large amount of steam-power proposed to effect the same object. The interception of the sewage from these streams would only be an extension of the principle already recognised, and would not only afford an opportunity of making them available as a much more economical motive power than steam, but also admit of their being discharged into the Thames at their natural outlets; by which means the quantity of sewage to be transmitted would not be increased by the addition of the contents of these streams, and the Thames would continue to receive them for the benefit of its navigation, thus effecting three important objects of advantage, and which can be easily accomplished by placing an iron pipe either in or under the bottom of each stream, according to their size and declination, which might—where necessary for self-cleansing—be thus improved. Any power that might be required in addition to that of these streams could be obtained by making available the current of the Thames, or the adoption of steam; but every person practically conversant with the application of water as a motive power will admit that it is not only much more economical than steam-power, but also much easier managed, and wherever it is available, it should be adopted in preference thereto; but the general use of steam-power, from its availability under all circumstances, tends to the neglect of hydraulic power even when available.

The transmission of the sewage to the east and west from the valley of the Fleet renders it available for land peculiarly adapted for its reception, more particularly on the north of the

Thames. There are districts east and west of the metropolis, of many square miles of extent, of such a depth of gravel as to constitute natural filter beds capable of absorbing any quantity of sewage that could be applied, and situated so low as to admit of more than half the sewage on that side of the river flowing there by gravitation, and also not so distant as to prevent the dairymen of the metropolis removing their cows to them, to consume the immense produce that would be available for their support. Such produce is enhanced in value in proportion to its nearness to town; even the sewage of Hampstead and Highgate, which are included in the metropolitan area, can be thus applied to land conveniently situated for the purpose, but should all the sewage of the metropolis be conveyed to any one place on each side of the river, it could not be applied to the land, without the expenses of pumping to a considerable elevation, and of transmission to a much greater distance; hence it must be evident, that to bring the sewage down to such low places, will not only be incurring an unnecessary expense in the first instance, but also necessitate the incurring of considerable additional expenses for its transmission to the land.

The immense quantity of produce obtained from land by the use of sewage and manure in a liquid state, was fully verified in 1846 before the Committee of the House of Commons, and that the application of manure in a liquid state is by much the less offensive. In the case of the Edinburgh meadows yielding a rental of upwards of 20 *l.* per acre; the sewage used there proved on analysis to be similar to that of London. At Mansfield, land has been raised in value, from a rental of 4 *s.* 6 *d.* per acre to yield produce worth 11 *l.* per acre, and that by the application of sewage containing much less fertilising matters, and the increased produce obtained by Mr. Harvey near Glasgow by liquid manure is more than double the quantity that any amount whatever of solid manure could produce. These facts have been since then admitted by all the authorities who have investigated the subject, which has led to the adoption of liquid manure on several farms.

And, although it was stated by a compiler of agricultural statistics, in a meeting at Tiptree, a few years ago, that, "However sewage and liquid manure were adapted for the humid climate of Scotland, such might not be suitable for the drier climate of London;" yet quite the contrary is the result, as it is much more suited to a warm, dry climate, where the greatest obstacle to the progress of vegetation is deficiency of moisture, which manure in a liquid state not only supplies, but is available as food and drink for the plants during every stage of their growth, and which enables the farmer to save and use the whole of the fertilising materials produced on his farm, instead of losing more than half of them when kept in a solid state. Some farmers, after having used the black liquid which has been washed by rain out of the farm-yard manure, after it has been completely decomposed in the heap in the yard, without much favourable result, have been led to doubt as to the advantages of the use of manure in a liquid state; but such black liquid, being principally a solution of carbon, derived from the heap after the most fertilising animal materials had been dissipated in a gaseous form, while undergoing decomposition, can be no test whatever as to such advantages, which are produced principally by the soluble animal products contained in liquid manure, hence, the necessity of its preparation and management being conducted by those who have experience on the subject.

Upon due consideration of all these advantages, viz.:—

First. The saving in the cost of construction of works.

Second. The avoidance of great difficulties and risk in their construction.

Third. Greater efficiency of drainage in securing self-cleansing power, preventing the necessity of incurring expenses; for cleansing, flushing, or ventilation.

Fourth. Annual saving of expense in the operations and management of works.

Fifth. Greater facility for repairing works.

Sixth. The obtaining of a rental for the sewage, ample to liquidate the cost of the Main Drainage.

Seventh. Conferring on occupiers of land the supply of manure on the most favourable terms.

Eighth. The supply of agricultural produce to the inhabitants on better terms.

Ninth. Securing to the Thames its original volume of water, so as to preserve its navigable efficiency.

It is expected that the Board will carry out the suggestion of their engineer, in his Report of January the 21st 1854, page 16, wherein he states, "But when the result of the inquiry, now pending respecting the practicability of effectually dealing with the contents of the sewer in the metropolis shall be ascertained, some considerable modification of this portion of the Main Drainage Scheme may be advisable." Hence, such a modification of the scheme as will secure all these advantages cannot be considered inconsistent with their proceedings, as the whole of the sewage of the metropolis is now being so "effectually dealt with," and that by the occupiers of land entering into written engagements to consume the sewage continuously to the extent of the supply, on such terms as to produce the most satisfactory results.

The foregoing arrangement for the more effectual drainage of the metropolis, at the same time securing the utilisation of the sewage for the benefit of all parties concerned, having been founded on facts and practical results, are submitted without hesitation to the most stringent investigation of practical gentlemen of science, confident of their being able to sustain such an ordeal.

(signed) *John James Moore,*
Scientific and Practical Agriculturist
and Agricultural Engineer.

6 Pump-court, Temple,
30 November 1858.

N.B.—Plans and estimates of the necessary modification of the intended works, so as they may be available for the remunerative application of the sewage, as above stated, are in course of preparation, and will be delivered when completed.

15 December 1858. *J. J. M.*

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6, Pump Court, Temple,
Gentlemen, 10 August 1859.

In August last I handed to your Chairman a communication on "the best mode of arranging the drainage of the metropolis in order to apply the sewage to agricultural purposes" in such a manner as not only to obviate all the difficulties involved in the plans entertained by the Board, but also from which a pecuniary return could be obtained adequate to liquidate the expenses to be incurred.

This communication not appearing to receive the attention which its importance merited, the occupiers of land available as an outlet for the sewage as manure were called upon, who not only expressed a desire to obtain it as such, but have also entered into written engagements to consume it continuously on such terms as would secure to the Board a rental equal to 4 per cent. on the expenses to be incurred, and which were laid before the Board by a memorial through one of its members in the month of October following.

Conceiving that the immense number of theoretical schemes which had been forwarded to the Board professing to effect the same object were calculated to prevent the investigation of the subject to the extent necessary to ascertain the most efficient and practicable for the purpose. It was considered advisable to prove to the Board that the arrangements handed to their Chairman, as before stated, was the result of long experience and thoroughly practical, in proof of which "Facts and results illustrative" thereof were transmitted to each member of the Board in December last, in order that they might individually have an opportunity during their leisure of giving that attention to the subject which its importance to all parties so justly merits.

With respect to economy and efficiency in the construction of the works necessary to effect the objects desired, these facts referred to the substitution of hydraulic power as being locally available instead of steam and by this application of the natural streams which flow through the metropolis being not only more economical but more efficient, and capable of being so arranged as to be self-acting in case of floods, so that the prevention of the inundation or flooding of the low grounds need not depend on the constant and uninterrupted attention of servants during all hours, but be completely self-regulating, thus precluding any risk from incidental neglect.

This reference to hydraulic power was expected to have led to the investigation of its available extent by the Board before deciding upon the more expensive power of steam, but such investigation not appearing to have taken place but an arrangement being in progress for the adoption of steam, it has been considered advisable to obtain facts as to the extent of the hydraulic power so available, the result of which proves that there is ample hydraulic power thus available for the purpose and in order to afford the Board an opportunity of taking into consideration the advisability of substituting this available hydraulic power instead of steam before contracts for the latter are entered into, I beg leave to lay before them the foregoing result and shall be ready to communicate information on the subject when afforded an opportunity.

I have, &c.
(signed) *John James Moore,*
S. & P. A. & Agricultural Engineer
To the Metropolitan Board of Works.

Metropolitan Board of Works,
Sir, 15 October, 1859.

I beg to inform you in accordance with the direction of the Metropolitan Board of Works, that after careful consideration of the proposal contained in your communication of the 10th August last, and in a previous letter dated 20th October, 1858, suggesting the use of hydraulic power in lieu of steam for lifting the sewage of the metropolis, they have arrived at the conclusion that the principle is not one which would be applicable to their works.

I remain, &c.
(signed) *E. H. Woolrych,*
Clerk of the Board.

J. J. Moore, Esq.,
6 Pump Court, Temple, E.C.

6, Pump Court, Temple,
Gentlemen, 11 January 1860.

In a communication handed to your Chairman in August, 1858, I suggested the best mode of effectually draining the Metropolis so that the sewage might be available in a liquid state as manure for the occupiers of land in the vicinity; stating at the same time, that the mode suggested could be effected for much less expense than that entertained by the Board, and also afford such facilities for its application to the land as to enable the Company who undertook the same to pay the Board a rental equal to four per cent. on the cost necessary to be incurred. On that occasion, the Chairman stated that he had no doubt but the Board would much prefer the sewage being applied as manure to the land, than its being otherwise wastefully disposed of, and many numbers of the Board have occasionally expressed themselves in a similar manner. Being convinced from experience of the value of the sewage of the agriculturists, and having formed the Metropolitan Sewage Manure Company in 1846 to supply them with it, (but which became marred by Directors) these expressions induced me to secure occupiers of land as customers for the sewage in the expectation that such an outlet being obtained would have induced the works to be so modified for the purpose and transmitted a communication to each member of the Board in December 1858, to that effect.

Not receiving any definite official reply to these communications, and being advised that as no consideration would induce the Board to make any alteration in the works that had received their approval it would be most advisable to make the sewage available as manure for the land from the works so approved of. In accordance with this advice a company* is being formed, composed principally of the customers who have entered into engagements to use the sewage continuously to a greater extent than the Board's Works at present progressing can ultimately supply, and occupiers of land sufficient in extent to use the whole of the sewage of the Metropolis are in progress of being secured for the same, which will prevent the necessity of expenses being incurred to deodorize any portion of it.

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* Herewith is a Prospectus of the Company at present forming.

Under these circumstances I most respectfully solicit the attention of the Board to the subject in the expectation with some confidence that upon due consideration they may deem it most consistent with the interest of all parties to grant the sewage as manure for the land which is being secured as an outlet for it, instead of its being washed by transmission towards the sea.

Should the Board require an engagement to deodorize any portion of it, when necessary, upon sanitary grounds such would be acceded to.

Any further information which the Board may require on the subject, I shall be ready to afford, on receiving an intimation to that effect.

I have, &c.
(signed) *John James Moore,*
Scientific and Practical Agriculturist
and Agricultural Engineer.

To the Chairman and Members
of the Metropolitan Board of Works.

PROSPECTUS of the Liquid Sewage Manure Company (limited).

A Commercial Medium between Public Bodies and Agriculturists.

CAPITAL, 200,000 *l.*, in 20,000 shares of 10 *l.* each, 2 *s.* 6 *d.* per share payable on application for shares to be applied to the payment of preliminary expenses which have been paid by the promoters as they accrued, and the remainder in compliance with calls of not more than 2 *l.* each, at intervals of not less than six months.

Directors.

} Supervisors of Sewage Distribution.

Supervisor of Books and Accounts.

Managing Director:

John James Moore, Esq., 6, Pump Court, Temple,
Scientific and Practical Agriculturist and
Agricultural Engineer.

Bankers:

The Bank of London.

Secretary:

Lewis C. Hertslet, Esq.

Offices:

No. 2, Derby-street, Parliament-street, s.w.

THE improved drainage of the Metropolis and the preservation of the Thames from pollution have as sanitary consideration, engaged particular attention during many years, and Parliament made several enactments to prevent any materials being discharged into the river that tended to pollute the river, notwithstanding which, in 1828 it proved to be so impure as to be unfit for the use of the inhabitants. It was then the late Mr. John Martin energetically took up the subject of utilising the material which polluted the water, and after due investigation of its value, a most influential company was formed in 1836, who proposed disposing of the solid portion of it as manure. Further investigation, however, proved that such portion was comparatively of no value, and it was then proposed to convey the liquid sewage by a large intercepting sewer on each side of the Thames to the land below the metropolis, but upon due examination of the ground through which these sewers had to be constructed, and of other difficulties to be overcome, it was the opinion of the most talented engineers that these constructions were impracticable, therefore this mode had also to be relinquished, and the subject remained in a state of abeyance until the experience of the late Mr. Smith, of Deanston, came to bear upon it, who suggested that the same means which supplied the town with pure water were equally available to transmit the sewage water as manure to the land. This suggestion induced Mr. Martin in 1845 again to resuscitate the subject, and he then obtained the co-operation of the promoter, a scientific and practicable agriculturist of many years' experience in the profitable use of liquid manure, who undertook the formation of a company, and, with the assistance of Mr. Smith, had the whole measure in all its bearings thoroughly investigated by a Select Committee of the House of Commons, who were assisted by a commission of scientific gentlemen specially appointed for the purpose. Being opposed by the authorities from a fear that the application of the sewage as manure necessitated the formation of reservoirs, wherein it would decompose, throw off impure gases, and become injurious to health, and a nuisance wherever such an application of it took place; but the promoter, from his extensive experience under all the circumstances requisite for its application, totally free from those pernicious consequences, proposed an arrangement without any collection into tanks or reservoirs, and provided for its being continuously absorbed by the soil (the natural and best deodoriser) in a flowing state within a few hours after leaving the houses, thus preventing decomposition or any foul gases. This arrangement, on being tested, proved satisfactory; which, with the evidence he adduced as to the result of the application of the sewage to the meadows of Edinburgh and Mansfield, where it has been the means of increasing the value of land in the latter case from 4 *s.* 6 *d.* to 11 *l.* per acre, and in the former from 40 *s.* and less to 20 *l.*, 30 *l.*, and even in some cases to upwards of 40 *l.* per acre, met and overcame all the objections and obstacles presented on that occasion, which were effectually set aside by the evidence of these facts, and such modifications as were available as practical appliances suitable for the purpose, and ultimately obtained from the Committee a highly favourable report, stating that it is only by such means "the important purposes of cleansing our towns, purifying our rivers, and enriching our soil" can be accomplished, and Parliament passed an Act to incorporate the company, and enable them to carry out the object. But upon the operations of the company coming under the control of directors not conversant with the subject, who adopted extremely prejudicial measures, which Mr. Smith and his coadjutor endeavoured to prevent, but without effect; and, in order to avoid being implicated in the failure of the company, which had been founded upon the strength of their practical knowledge of the subject, they issued a

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protest* to each shareholder and retired from the company.

This brief sketch of the progress the important subject had made up to the formation of the Metropolitan Board of Works, will show that they are now contending with the same difficulties and obstacles which beset and obstructed the progress of Mr. Martin's party in 1836. And although the sewage of the metropolis is estimated by all who have duly investigated the subject, to to be worth 1,000,000 sterling annually, this Board, after devoting much time and labour in discussion, have decided that they cannot undertake any commercial matter, such as treating with the agriculturalists to supply them with the sewage, however advantageous it might be, and have resolved to construct works to convey the sewage seaward, and thus to waste a material of immense value to agriculturists who have to obtain guano as a substitute from most distant parts of the globe.

Under these circumstances it is necessary that a company be formed, to occupy the position of a commercial medium between the Metropolitan Board of Works and the agriculturists, to treat and arrange for the supply of the sewage, and to construct the necessary works so as to secure its continued consumption, and also obtain such a return as shall enable the company to make a liberal dividend to the shareholders.

In 1846 a project, to manufacture the sewage into solid manure, was brought before Parliament by certain parties, and referred to the aforesaid Committee and Scientific Commission; and, although no Act was obtained for the purpose, the parties determined in opposition to the strongest advice from a practical source to proceed with such manufacture, and during its progress issued reports of its success so favourable as to mislead the authorities in charge of the drainage of the Metropolis and other towns, which the most decided statements to the contrary founded on practical results failed to counteract. But after an outlay of about 70,000 *l.* at Puddledock, Leicester and Tottenham, during a period of 12 years, the whole process has proved to be a total failure, and admitted to be such by the parties themselves.† The most active directors in the former company against the proceedings, of whom the promoter protested, were, at the commencement, desirous of adopting the same course, and were only with difficulty restrained for a short time from such a futile process; they, however, persisted, and put their desires into operation, and after a considerable expenditure in attempting to convert the sewage into solid manure by the use of charcoal also failed of suceess. Therefore, as it appears that nothing but experience purchased at an excessively dear rate effectually teaches some persons, in order to prevent the capital of this company being similarly misapplied, the designation "Liquid Manure Company, limited," has been adopted.

The Board of Directors of this Company is to be composed of seven members, (the manager being one by virtue of his office), and in order to constitute an efficient executive body each of the other six members is to take the supervision of a particular department, under the general direction of the Board, for which due compensation is to be made according to the time and services rendered in such supervision, and not to be less than 5 *s.* per hour.

Occupiers of land having been secured as customers for the sewage, and as many of them have proposed to take shares in the company, in order to secure a preference in the supply it is advisable that the customers generally become shareholders in proportion to the extent of land occupied. Shares held by them to the extent of 1 *l.* per acre (calls on which will spread over three or four years) will secure the supply of a manure much more available in its application under all circumstances than that now used, particularly obviating the disadvantages of extremely dry weather, and at the same time costing not one quarter of the present much inferior article. Thus occupiers of land have the opportunity not only of placing themselves in a position to derive all the advantages the material is capable of producing, but also to establish the company on such a basis as to secure its permanency.

The customers for the sewage who become shareholders will have a preference of supply in their respective districts, and such preference in the order of precedence in which they become shareholders.

Promoter:

John James Moore, Scientific and Practical Agriculturist and Agricltural Engineer, 6, Pump Court, Temple.

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* To the Chairman and Directors of the Metropolitan Sewage Manure Company, and to their Secretary.

We, the undersigned, being shareholders in the Metropolitan Sewage Manure Company, do hereby give you notice that proceedings and works which it is understood are commenced, or about to be commenced, and made by the order and direction of the directors of the company for the purpose of using and distributing water taken from the Counter's Creek sewer, otherwise the Kensington Canal, are not such works and undertakings as are within the powers conferred by the Acts of Parliament passed for incorporating the said company, and enabling the company to alter the line of their works. And that the monies belonging to the company cannot be lawfully used or applied in or about such works and undertakings; and we do hereby protest against such works and undertakings being commenced or carried on by or under the orders of the directors, or as an operation of the said company, and the employment of any money belonging to the company in or about such works or undertakings. And we do hereby further give notice that if such works or undertakings are commenced as an operation of the said company, or any of the funds of the company are applied towards the making or completion thereof, or any other purpose not warranted by the Acts of Parliament constituting the misapplication of the monies belonging to the company, and shall seek to make the persons by whom such application shall be made or directed liable for the same, and for the costs of such proceedings.

Dated 6th November 1848.

James Smith, 13, Queen-square, Westminster.
John James Moore, Baljean, and others.

† See Mr. Weeksteed's evidence before the Committee of the House of Commons on purifying the Thames (1858), in which he admitted having put up the works at Leicester for the manufacture of the sewage with lime into solid manure in the expectation of its being profitable; but the result has been that the farmers after trying it will not even go to the expense of carting it, consequently it has accumulated. He also stated that he could deodorise the sewage of London in the same manner, but did not think that land could be had to put the solid material on, but it might be put into barges and sent to the sea.

6, Pump Court, Temple,
Gentlemen, 5 July 1860.

In compliance with your advertisement for tenders to dispose of the sewage of the metroplis, I hereby tender to take all the sewage of the metropolis from the works of the Board in the most favourable situations that can be arranged with them, in order to its transmission in a liquid state as manure to occupiers of land who enter into engagements for its consumption, and so transmitted through closed or covered conduits in a continuous flowing state, without being pounded or collected into tanks or reservoirs, and be absorbed by the soil within from six to ten hours of its leaving the works of the Board, so that no decomposition can take place to produce obnoxious gases.

That the sewage be granted for a period or term of 90 years or other reasonable period, the Board receiving for the same during the first 14 years a nominal or peppercorn rent, and at the expiration of that period one-half of the profits that may be derived therefrom, after deducting 10 per cent for the capital invested in the transmission and application of the sewage as manure to the land; or at the expiration of the said period of 14 years, the Board to receive such reasonable return as may be awarded by arbitrators appointed by the Secretary of State of the Home Department for that purpose.

For the due fulfilment of these terms occupiers of lands to the extent of nearly 100,000 acres have engaged so to use the sewage on terms of which the annexed is a copy, and they are being formed into a joint stock company with a capital of 200,000 *l.*, to be increased as required to 500,000 *l.* to carry out the same.

Thus the Board can be saved from an outlay for deodorizing and other works to the extent of about 500,000 *l.*, and also ultimately receive a rental for the sewage that may be applied in the liquidation of the funds advanced for the main drainage, and so relieve the ratepayers to a considerable extent besides conferring on them a considerable benefit by the great increase of local agricultural produce thus derived, reducing the price thereof at the least 25 per cent., more particularly in the article of milk.

I have &c.
(signed) *John James Moore,*
Scientifie and practical Agriculturist
and Agricultural Engineer.

To the Chairman and Board of the
Metropolitan Board of Works.

Whereas the Metropolitan Board of Works having to intercept the sewage of the metropolis from flowing into the Thames, and having no other outlet for it but the sea, while the agriculturists are so deficient in their supply of manure as to have it imported from the most distant countries at considerable expense, therefore we, the undersigned owners and occupiers of land in the vicinity of the metropolis, being desirous of obtaining the sewage in a liquid state as manure, do hereby severally agree, engage, and bind ourselves to receive and consume the sewage continuously as manure to the extent that it is capable of being so applied on our respective holdings, under the management of John James Moore, agricultural engineer, on the terms attached to our respective names, and which we severally agree to pay him for obtaining the transmission of the sewage to the most favourable situation on our respective holdings, and for his management thereof, and will severally execute any deed or deeds necessary for the due fulfilment thereof when hereunto required.

W. A. 1,000 acres.
J. A. 1,800 acres.

6, Pump Court, Temple,
Gentlemen, 10 July 1860.

On Thursday last, in compliance with your advertisement for tenders for disposal of the sewage of the metropolis, I delivered a tender, for which the Board, on the following day, referred to the consideration of a committee.

As numerous theoretical schemes for the consolidation of the sewage into a profitable manure had been urged upon the attention of the Board, and also on the attention of their predecessors, which tended to mislead them into futile experiments, the advertisement was very judiciously framed, so as to afford these theorists an opportunity of testing their crude ideas on the subject; but the experience of the last 14 years, of the futility of those ideas has so satisfactorily decided the matter, by the losses sustained at Puddledock, Liecester, Tottenham, and Stanley Bridge, and which losses no arguments that many years experience adduced could prevent; but these losses have had the effect of preventing the Board being again teased on the subject.

In consequence of the advertisement being so framed in such a general and comprehensive manner, my tender referred also to a general mode of procedure in affecting the much desired object, as a more minute detail might have been considered more confusing than elucidatory of the subject; but when the Committee are prepared to investigate the subject thoroughly, and favour me with special notice to that effect, and the particulars thereof, the same facts and practical results adduced by 18 years' experience, which in 1846 converted the opposition of all the Government authorities into their support of the subject (although subsequently marred by presuming ignorance), will, it is confidently expected, satisfy the Board not only of its practicability, but also of the ultimate realisation of all the advantages referred to in my tender. The term of 14 years before the Board can derive any return from the sewage may appear too long; but when it is evident that the Board's drainage works will not be complete for some years to come, and the Company's works for the transmission of the sewage have to be afterwards constructed, and the cultivators have then to derive therefrom a year's produce, and realise the marketable value thereof, before they make their payments for the same, that term cannot be considered unreasonably too long. It is admitted that small portions of the sewage will be available for the use of the Company in the course of a few months; and the Company will be prepared to construct their works as the different portions of the Board's works are completed; but the returns from the sewage so made available, will not be more than is necessary to liquidate the preliminary expenses, and afford a reasonable return for the capital invested; but, at the expiration of 14 years, the subject

App. No. 14. subject will be fully developed, and a return afforded for the benefit of the ratepayers.

I have, &c.
(signed) *John James Moore,*
Scientific and Practical
Agricultural Engineer.

To the Chairman and Board of the
Metropolitan Board of Works.

London Sewage.

Metropolitan Board of Works,
Sir, 1 August 1861.

I AM instructed to inform you that a meeting of the Main Drainage Committee of the Metropolitan Board of Works will be held at this office on Tuesday next the 6th instant, at two o'clock P. M., when your tender to take the sewage of the metropolis will be considered; and I am to request the favour of your attendance on that occasion.

I am, &c.
(signed) *John Pollard,*
Clerk of the Board.

John James Moore, Esq.,
6, Pump Court Temple.

London Sewage.

Metropolitan Board of Works,
Sir, 25 October 1861.

I AM instructed to inform you that a meeting of the Main Drainage Committee of the Metropolitan Board of Works will be held at this office on Tuesday next, the 29th instant, at twelve o'clock at noon, when your tender to take the sewage of the metropolis will be further considered, and I am to request the favour of your attendance on that occasion.

I am, &c.
(signed) *John Pollard,*
Clerk of the Board.

John James Moore, Esq.,
6, Pump Court, Temple.

Metropolitan Board of Works,
Spring Gardens,
Dear Sir, 16 November 1861.

I AM directed to inform you that your communication, in reference to the sewage of the metropolis, together with others of a similar nature, having been under the consideration of the Committee, to whom the subject has been referred, they have arrived at the conclusion that, before coming to a final decision with respect to any of them, it would be necessary that they should have every possible opportunity for testing the efficiency of the scheme in an engineering and chemical point of view, and for satisfying themselves that the requirements of the Act of Parliament relating to the subject shall in no way be infringed, by the creation of a nuisance in carrying out the works.

With this view I am to request that you will be good enough to supply a map and sections, showing the area of the intended operations, the level of its surface, and the lines, level, and sizes of the intended aqueducts, indicating the various kinds of surface soil with which it is proposed to deal, and showing in detail what mode of subsoil drainage it is intended to adopt, if any, with the size, depth, and inclination of the several proposed lines of drainage, together with descriptions and particulars of the pumping power to be employed, the number of lifts and the nature of the outfall.

Also a statement showing the manner in which it is proposed to work the scheme, what kind of powers will be taken for dealing with the land to be operated upon, and how owners and occupiers are to be treated with, what quantity of sewage will be taken up daily, over what quantity of land it will be distributed, what depth it will occupy, over that area of land, and if it be intended to employ varying quantities, at different seasons, what that variation will be.

Also, a full statement of the means of deodorisation, if any, the chemical agency employed, and the details of their mode of application, and what arrangement, if any, it is proposed to make for dealing with the heavy deposit.

Also an estimate, showing, separately, the cost of the engines and pumps, if any, the conducting pipe or sewer, the distribution and deodorising apparatus and the subsoil drainage, together with the annual working expenses of each of these three heads of expenditure.

I am, &c.
(signed) *John Pollard,*
Clerk of the Board.

John James Moore, Esq.,
6, Pump Court, Temple.

6, Pump Court, Temple,
Sir, 7 January 1862.

CONCEIVING that my not having yet complied with the requisition made on the 16th of November last, to supply the Board with the particulars respecting the sewage therein stated, might lead them to think that the same might have been declined by me, in order to prevent which I beg leave to state that to obtain such particulars required, referring to a great number of farms, and to occupy much time for their inspection, which is in advanced progress; I therefore beg leave to inform the Board that a map, exhibiting the various farms in Essex for which the greatest portion of the sewage is required, will be ready to be laid before them in a short time, and that maps of the other districts requiring the sewage are also in progress and will be completed at the earliest period available for the purpose.

As the Board very judiciously require to be informed of the nature of the soil to which it is intended to apply the sewage, so that the law respecting nuisances may not be violated, I have to state that no sewage shall be applied to marshy land, that the greatest portion of the land arranged for its application is a porous soil, some feet deep, capable of absorbing any quantity it may require as manure, and most of the small portion that is adhesive has been thoroughly drained 4 feet deep, and any of such soil that is not so drained shall be drained before sewage is applied to it, so that no sewage will be applied to any land that is non-absorbent, therefore no sewage whatever shall be allowed to stagnate and decompose, but that the whole of it shall be applied to the soil at all times in a continuous flowing state, and absorb thereby within from six to ten hours (according to distance) after having left the houses; therefore no decomposition can take place, or effluvia arise therefrom to become a nuisance, but should any doubt occur in this respect during very warm weather, there can be no objection to the use of perchloride of iron to counteract the same.

All other particulars necessary for the informa-
tion

tion of the Board shall be forwarded as early as time will admit.

Should the Board require to participate in the management of the sewage so applied, they could elect two directors to represent their authority in such management.

Any other reasonable conditions that will not obstruct or discourage the raising of capital to carry into effect so desirable an undertaking will be complied with.

I have &c.
(signed) *John James Moore.*

John Thwaites, Esq.,
Chairman of Metropolitan Board of Works.

6, Pump Court, Temple,
6 February 1862.

Sir,

In my letter of the 7th ult., the quality of the land in Essex held by the persons who have agreed to take the sewage, to the extent of upwards of 20,000 acres, was particularly described, with the time of its absorption by these lands so as not to be a nuisance; and herewith I beg leave to present an Ordnance Map, upon which is traced and coloured the said lands, showing their relative situations.

As the sewage can be applied to such lands without being any nuisance, the nearer these lands are to the source of supply the higher will be the cost of transmitting the sewage to them, and also the greater will be the value of the produce derived therefrom; and it is most likely that such a quantity of valuable produce being obtainable near town, at a price considerably lower than any cattle-food now attainable, will induce the dairymen of the metropolis to remove their establishments to such lands, where their cattle will have sufficient space for cleanliness and health, thus relieving the metropolis of one of its great nuisances, and at the same time obtaining for the inhabitants good and wholesome milk on reduced terms.

As the 24th Vict., c. 133, authorizes such arrangements as will enable the sewage of the metropolis to be applied, with the approbation of the landholders, to the district herein referred to, and as the "Metropolis Local Management Acts" fully authorize the Board to dispose of the sewage of that district, it is not necessary to obtain a particular Act of Parliament for the purpose.

The elevation of these lands range from 10 to about 150 feet above Trinity datum; to a portion of them the sewage from the Board's Works will flow by gravitation, and to those portions at the extreme height, to overcome friction and secure free delivery, hydraulic pressure equal to 200 feet is required: but a large portion of these lands can be supplied from the Board's Works by a very moderate extent of steam-power, and should the Board be disposed to appropriate their surplus power, intended to be provided as a reserve, it might be so applied, and thus an annual pecuniary return could be obtained by them for such power; otherwise the whole of the steam-power necessary for the transmission of the sewage to this district will have to be supplied by the Company now forming, and which would have been completed but for the delay and uncertainty of the grant from the Board to carry out the object.

As it will occupy much time and incur considerable expense to ascertain the particular elevation of these lands respectively, so as to frame a particular estimate of the steam-power necessary to transmit the sewage to them, it is hoped that the information I have already forwarded, and now render to the Board, will prove so far satisfactory; and any further particulars that they may require I shall be ready to communicate as soon as available.

I have, &c.
(signed) *John James Moore,*

John Thwaites, Esq.,
Chairman of the
Metropolitan Board of Works.

Metropolitan Board of Works,
17 February 1862.

Sir,

At the meeting of the Metropolitan Board of Works, held on Friday last, the subject of the several propositions for taking the sewage of London was brought under the notice of the members, and I laid before them the papers relating to your scheme; but the attention of the Board having been called to the fact of the intention of Government to acquiesce in the appointment of a Committee of the House of Commons to inquire into the best means of utilising the sewage of the cities and towns of England, with a view to the reduction of local taxation and the benefit of agriculture, they adjourned the further consideration of the subject until that Committee shall have made their report.

I am, &c.
(signed) *John Pollard,*
Clerk of the Board.

John James Moore, Esq.,
6, Pump Court, Temple, E. C.

6, Pump Court, Temple,
9 July 1863.

Sir,

In compliance with the advertisement that the Metropolitan Board of Works will receive tenders for the disposal of the sewage discharged by the main outfall sewers, I hereby continue and repeat my tender for the same, made to the Board on the 5th July 1860, with my subsequent communications to the Board explanatory thereof, dated 10th July 1860, 7th January 1862, and 6th February 1862, in the latter of which I referred to the Board employing their surplus engine-power in pumping up the sewage for our Company and be compensated for the same. Upon further consideration of the subject, in order to simplify and define the relative position of the Board and our Company more particularly, I hereby propose that our Company do pay at the rate of one farthing per ton to the Board for every ton of sewage raised for our Company by the Board's steam-power to an elevation of 200 feet, which is to be considered a compensation for such power and payment for the sewage. Should the quantity (80,000,000 gallons daily) of sewage estimated by your Consulting Engineer be realised, the payment thus to be made to the Board by our Company, who have customers for the whole of it when in free operation, would amount to nearly £136,000 annually, the half of which would not be expended by the Board in such steam-power, leaving more than the other half of this sum as compensation for the sewage: at the same time the Board would retain complete control of all the steam-power employed in the drainage of the metropolis.

The report of the Commissioners on the utilisation of sewage, as well as the evidence adduced before the Select Committee of the House of

Commons last Session, corroborate the estimate I had made of its value to the occupiers of land in 1858, when they entered into engagements with me to pay one penny per ton for the sewage delivered to them, and for my directing the management thereof.

As the Company will consist principally of proprietors and occupiers of land, as customers and shareholders thus doubly interested in the undertaking, they may be considered the best security to effect the object.

I have, &c.
(signed) *John James Moore*,
Scientific and Practical
Agriculturist and Engineer.

To John Pollard, Esq.,
Clerk of the Metropolitan Board of Works.

55, Mornington Road, Regent's Park,
Sir, London, 25 February 1859.

Several gentlemen in connection with myself having formed themselves into a Company, under the title of "The London Sewage Utilization Company," are desirous of making propositions for the employment of the London sewage. They will be glad to learn when they may have the honour of laying their plans and propositions before your Board.

I am, &c.
(signed) *Charles H. Roberts.*

To John Thwaites, Esq.,
Chairman of the
Metropolitan Board of Works.

55, Mornington Road, Regent's Park,
Sir, 7 March 1859.

May I request the favour of your laying the enclosed letter before the Main Drainage Committee, so that it may come forward for consideration at their meeting to-morrow?

I am, &c.
(signed) *Charles H. Roberts.*
C. H. Woolrych, Esq.

55, Mornington Road, Regent's Park,
Gentlemen, February 1859.

On the part of the Promoters of the London Sewage Utilization Company, I have the honour of conveying to you the following propositions, on accepting which the ratepayers of the metropolis will be benefited by savings in the following respects:—

1. In the formation of a portion of the main sewer.
2. In the construction of reservoirs.
3. In the erection of deodorizing works.
4. In avoiding the annual expenses of deodorizing, including the cost of lime and the heavy charge for the removal of the sludge deposit, which has been variously estimated at from 40,000 *l.* to 200,000 *l.* per annum.

We propose to apply liquid sewage to the irrigation of grass-land, and are prepared to irrigate 1,000 acres with such sewage as you can deliver to us in the course of two years from this date.

At the expiration of two years from the time of our first receiving the sewage, we shall be at liberty to call on you to deliver to us the whole sewage.

By accepting our offer the ratepayers will also avoid the possible contingency of having ultimately to convey the sewage to the sea, which it is feared will be necessary, as the deodorizing by lime removes only three-fourths of the soluble organic matter from sewage.

For relieving you from the above outlay in plant and annual expenses of deodorizing we propose making you no charge.

Should our offer be favourably entertained, we shall feel obliged by your not making your decision public, as we should then labour under greatly increased difficulties in completing our arrangement for the land.

I am, &c.
(signed) *Charles H. Roberts.*

To the Main Drainage Committee of the
Metropolitan Board of Works.

55, Mornington Road, Regent's Park,
Dear Sir, 15 April.

I think I have replied fully to all the questions you were kind enough to address me on the 5th instant.

With your permission, I will wait on you to-morrow morning, to learn if I may be in attendance next Tuesday.

I am &c.
(signed) *Charles H. Roberts.*
John Thwaites, Esq.

Gentlemen, London, 14 April 1859.

In reply to your inquiry, I beg to hand you the following explanation of the details of my scheme for utilising the sewage.

The amount of liquid which can be spread over a given surface and filtered in a given space of time through a previously determined thickness of material, must always depend on the nature of that material, be it sand, gravel, or clay, and on the density of the liquid to be filtered, and its temperature.

Thus in the case of the soil of England, we often find three or four different sorts of earth within a very small area; hence the calculations applicable to one field might require to be essentially varied for the field next adjoining.

Again, at certain seasons of the year—nay, even at various periods of the day, the liquid with which we shall afterwards have to deal varies in its consistency and fertilising powers, so that experience alone can point out to us the best methods of dealing with such a material.

This experience we hope to gain in our experiment on about 1000 acres of meadow-land.

I propose, therefore, for the present to give only such a general outline of the plan we intend to adopt, as may lead your Board to see that we have carefully considered the various details of sewage irrigation, and that we are prepared to deal with this subject in a businesslike and efficient manner.

In applying the liquid sewage to irrigation by means of iron mains, with branches to the various panes or plots of grass, we expect to be able to avoid all the objections, in a sanitary point of view, that have been made to a system of open irrigation.

The liquid sewage from which the brickbats and other

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other extraneous objects have been strained, by means of a grating, is conveyed by the pipes to the highest point in each plot of ground; it is there emptied into gutters, which, when full, overflow the land.

As no ground could be formed without enormous expense with a prescribed fall, so as to permit the sewage to irrigate successfully each portion of the plot, contour gutters will be formed following the natural inclination of the land, these, in their turn, will be filled with what has run off from the ground of a higher level and when full will overflow to that surface which has not been previously irrigated.

By these means we shall prevent the sewage escaping into the ditches, without having previously filtered through a surface of earth, the land being divided like the squares on a chessboard, on the completion of the irrigation of one plot the next is proceeced with, and so on, until the quantity of land under cultivation has all been once watered, the irrigation of the first lot will then be recommenced.

When a large quantity of land is under cultivation, then several plots dispersed over the surface will be irrigated at one time.

Your Committee will remember that when asked what quantity of sewage I thought it might be possible to place, in the course of a year, on an acre of ground, I replied that I was led to believe under certain circumstances we might be able to employ such a quantity as would be equivalent to a depth of nine feet over the surface of the land.

It will readily suggest itself to your Board that where we may have failed in creating or do not find naturally an effective drainage, it will be impossible to filter through a depth of three or four feet of earth so considerable a body of liquid as above contemplated. I did not explain fully to your Committee that it was my intention to irrigate each plot of ground between the months of March and October once a month, and twice a month during November, December, January, and February, 16 applications, during each of which about 6¾ inches would be allowed to soak into the ground.

You also requested me to furnish you with the details of calculations, showing how I had arrived at the conclusion; that if it should eventually be found practicable to employ sewage equal to a depth of nine feet over each acre of land, 9000 acres would then suffice for the quantity of sewage produced on the completion of your works within the area drained into your main outfall channel at Barking Creek.

The maximum flow of intercepted rain-fall allowed for in the construction of the sewer on the combined area of the high, middle, and lower level Sewers, say 24,449 acres is equal to 79 inches per annum, which gives a total of 13,339 cubic feet per minute or 7,011,239,730 cubic feet per annum.*

It is a well known fact that the annual average rain-fall over the Metropolis is 24 inches, and that 15 inches pass off by evaporation, hence we have only to provide irrigation works for nine inches per annum, or 798,748,830 cubic feet total rain.

	Cubic feet.
The maximum flow of sewage during 310 working days -	3,186,403,200
Sundays and holidays (say one-fourth of working days) - -	141,321,400
During one year - -	3,327,724,600
From this must be deducted the 25° allowed for contemplated increase of population - -	831,931,150
Total sewage without rain fall - - -	2,495,793,450

Intercepted rain	798,748,830
Sewage - -	2,495,793,450
Rain and Sewage together - -	3,294,542,280

3,294,542,280; 392,040 square feet in one acre, 8,403 acres nine feet deep.

As a practical test for the correctness of these calculations, we may instance the case of Edinburgh, where the sewage of a population of 80,000 irrigates 325 acres of meadows. If we apply the same proportion to the land that may be irrigated near Barking Creek, we find that 8,361 acres will suffice.

Should, however, the actual yield of sewage exceed this calculation, and be capable of irrigating a larger area than above provided for, the promoters would derive greater advantages by extending the area of their operations.

I think Mr. Bazalgette will bear me out in the statement that he will find little difficulty in furnishing us, during the two years experiment, with an increasing quantity of sewage in proportion to the quantity we can employ over the 1,000 acres.

Your Board inquired if it would not be possible to furnish you with the names of the various promoters or shareholders in the Company about to support this project, and with particulars of the land we had secured for carrying out the preliminary experiment. I foresaw the inquiry, and the reason for it, and consulted my friends thereon.

A meeting of these gentlemen was held, at which it was decided that it was impracticable to form a company for treating a given substance before it was ascertained that some of that substance could be obtained.

The course they suggest is, that your Board should concede to me, in the nature of a preliminary or provisional concession, and as a trustee, the sewage on the terms hereinafter named, subject to my showing to the satisfaction of the Board, and within a period of time to be specified, say six months from the date of the provisional concession, that the promoters have not only the requisite funds, but have already secured about 1,000 acres for carrying out the preliminary experiment.

With the permission of your Board, I will here recapitulate the proposals I desire to make on the part of myself and friends for relieving the Board of a vast immediate and annual outlay.

Should your Board, upon mature consideration, be of opinion that the interests of the ratepayers will be best consulted by promoting the employment of the sewage as herein proposed. I hope you will agree to concede to me in trust for myself,

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* Vide Mr. Bazalgette's Report, May 1856, section 2, after page 26.

App. No. 14. self, and the various capitalists I represent, all such sewage as your Board shall from time to time be able to deliver from your main outfall channel now in progress of construction towards Barking Creek.

In the event of the undertaking proving satisfactory to the parties promoting it, at the expiration of two years from the first delivery of sewage, and they shall apply for the same, your Board shall further agree to deliver to me the whole sewage of the northern and southern portions of your main-drainage scheme, should it be ascertained that the sewage cannot be advantageously used, your Board shall agree that I shall be at liberty to cease to employ or receive it, and to terminate this arrangement on giving your Board reasonable notice.

It is hoped that your Board will afford every facility to enable me to receive the sewage at as early a date as possible, and will, for that purpose delegate to me such powers as your Board posseses for conveying and applying the sewage to lands for deodorization there, instead of the more costly process by the use of lime.

That in consideration of the very large outlay to be incurred in applying the sewage to irrigation, and the speculative nature of the undertaking, the sewage shall be conceded gratuitously for 21 years, after which time it shall be supplied on payment of an annual royalty of 3*s.* for every acre irrigated with sewage, and that I shall have the option on giving two years previous notice of giving up the receipt of the sewage at the expiration of such 21 years or at any time afterwards.

As the chances of being able to apply the sewage successfully will be greatly impeded by an arrangement of this nature being made public, before the land is legally secured, it is hoped your Board will feel that it is inexpedient to give this nature any unnecessary publicity for the space of six months.

Your Board will see that in accepting the foregoing proposals for the employment of the London sewage, the Metropolitan ratepayers will derive great advantages in the following (amongst other respects):—

1. By being saved the cost of the construction of reservoirs.

2. The great expense of establishing deodorizing works being rendered unnecessary.

3. By avoiding the large annual outlay for deodorization including the cost of lime, and of the removal of the sludge deposit which would entail a cost of many thousands of pounds annually.

In conclusion, I may state to your Board that I have given this matter a very full and careful consideration in conjunction with an engineer conversant with the subject, and I doubt not that with the hearty co-operation of your Board, it can be worked so as to be advantageous to the ratepayers as well as to the Company for whom I am acting.

I have, &c.
(signed) *Charles H. Roberts.*

To the Main Drainage Committee
of the Metropolitan Board of Works.

Metropolitan Board of Works,
Dear Sir, 11 May 1859.

By desire of the Main Drainage Committee, I beg to inform you that they will proceed on Tuesday next, the 17th instant, further to consider your memorial and subsequent communications on behalf of the London Sewage Utilisation Company, and will be glad if you can make it convenient to attend, in order to afford any explanations they may be in need of.

I am, &c.
(signed) *E. H. Woolrych,*
Clerk of the Board.

C. H. Roberts, Esq.,
55, Mornington Road, Regents Park.

55, Mornington Road, Regent's Park,
London, 12 August 1859.

Gentlemen,

When last I had the pleasure of presenting myself before you as an applicant for the sewage of London, you referred my propositions to your Main Drainage Committee.

The Committee at that time consisted of 12 members of your Board, but before I had an opportunity of bringing my plans under their notice it became a Committee of your whole Board. My propositions having therefore come under the consideration of most of your members, will, I trust, excuse the apparent informality of addressing myself directly to your Board.

Having had the pleasure of two interviews with your Committee, on which occasion I laid before it the details of my plans, I was led to understand I should shortly receive their decision.

Some months having elapsed, I made inquiry as to the cause of delay, and learnt that no decision could be come to until the report of your chemists had been received.

Dr. Hoffman's report having been presented to your Board last Friday, I trust you will not separate this day without favouring me with your decision as to the concession, and should you decide that it is expedient to endeavour to save the expenses of reservoirs, deodorising works, &c., and that the experiments should be left in our hands, I hope you will name some two or three members of your Board to finally arrange the terms on which we may receive the London sewage.

I am, &c.
(signed) *Charles H. Roberts.*

To the Metropolitan Board of Works.

Metropolitan Board of Works,
Sir, 26 October 1859.

The Chairman has directed me to inform you that the further consideration of your propositions was adjourned until after the disussion of Drs. Hoffman and Frankland's report, and that he has given instructions that the subject should be placed on the Agenda paper of the Committee to which the report in question is referred. He will, at their next meeting, remind them of your proposal, but, from the extent and importance of the subject, he is unable to state when they are likely to arrive at a definite conclusion.

I am, &c.
(signed) *E. Cresy.*

C. H. Roberts, Esq.

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Metropolitan Board of Works,
Dear Sir, 12 November 1859.

If not inconvenient will you be good enough to attend the Main Drainage Committee at their meeting on Tuesday next, the 15th inst., at two o'clock p.m., when they will resume the consideration of your proposal on the utilisation of sewage.

I am, &c.
(signed) *E. H. Woolrych*,
Clerk of the Board.

C. Roberts, Esq.,
55, Mornington Road, Regent's Park.

55, Mornington Road, Regent's Park,
My Dear Sir, 28 November 1859.

Since I had the pleasure of seeing you I have communicated with several of my friends and supporters, and they are of opinion that the rejection of the continuation clause after the expiration of the 21 years' concession would be a bar to our making the sewage commercially available unless the Board were to agree to take our works at a valuation.

By our proposition we agree to pay the full value of the sewage, to be settled by mutual arrangement with reference to the President of the Royal Institution of Civil Engineers, to appoint an arbitrator in case of need. Should the Board wish to take the irrigation into their own hands on the termination of our concession, we can, of course, have no objection to the introduction of a clause to that effect. As the population of London increases annually, so we propose to increase our works, but the rejection of the one clause without the introduction of the other would deprive the investment of all security, particularly when we bear in mind the immense difficulties you so ably pointed out that must ensue on our endeavours to procure compulsory powers over the land.

I have seen almost all the members of the Board (*ex officio*), and I did not hear from them an objection to our clause, so that I trust you will be enabled to retain it, in the manner we have proposed, in the draft agreement you have ordered to be prepared for next Tuesday's Committee.

I am, &c.
(signed) *Charles H. Roberts.*

E. H. Woolrych, Esq.
&c. &c. &c.

55, Mornington Road,
Regent's Park, London,
Sir, 18 January, 1860.

I have had the pleasure of communicating to my friends the fact that your Main Drainage Committee will, on Friday next, report to the Board on our proposition for employing the sewage. They earnestly request me to inform you that our labours will be in a great measure rendered abortive if this report and the discussion thereon are made public.

The owners and occupiers of the land over which we propose operating, will immediately be induced to demand an exorbitant price, thereby preventing our proceeding further in the undertaking.

May I therefore request that you will exercise your powers of calling a special meeting on Friday, so that any unnecessary publicity may be avoided until we have secured the land.

I have, &c.
(signed) *Charles H. Roberts.*

John Thwaites, Esq., chairman,
Metropolitan Board of Works, &c.

Metropolitan Board of Works,
Sir, 23 January 1860.

I beg to inform you that your letter of the 18th instant, relative to a discussion in public on the Report of the Main Drainage Committee, in reference to your proposition for the employment of the sewage of London, has been laid before the Metropolitan Board of Works, and I am directed to acquaint you that they are of opinion that the question is one involving such important public interest that they cannot consistently discuss it with closed doors. The Board have adjourned the consideration of the question until Tuesday next, and have instructed me to request that you will be good enough meanwhile to communicate to me the views of the parties with whom you are acting as to proceeding under these circumstances on the application.

I am, &c.
(signed) *John Pollard*,
Clerk of the Board.

Charles H. Roberts, Esq.,
55, Mornington Road, Regent's Park.

55, Mornington Road, Regent's Park,
Sir, 25 January 1860.

In reply to your favour of the 23rd instant, I have the pleasure of stating the result of my communication with my friends. They beg me to fully lay before your Board their reasons for having requested that the Report of your Main Drainage Committee, and the discussion thereon, might not at this stage of the proceedings be made public.

They request me, through you, to remind your Board that they do not appear before them as petitioners for the concession of sewage only, but as propounders of a system of natural deodorisation in competition with some 40 to 50 other systems and propositions.

They were induced to come forward in support of the scheme I had the honour of bringing before the Board, from my representations that it would not only effect the saving to the Metropolitan ratepayers of many thousands of pounds per annum that they would have to disburse in deodorising, but as pioneers of efficient means capable of general application for the utilisation of the sewage of towns.

As I had laid before them detailed calculations, showing a reasonable expectation of ultimate profit, if backed by the cordial support of your Board, (without which all endeavours will be fruitless), and of which they felt confident from the assurance I had received that the Board were prepared to deal liberally with any parties willing to embark their time and capital in a speculation of so uncertain a character.

As all their communications through me have been made to your Main Drainage Committee, to which all the members of your Board belong, they considered the fact of their scheme having, during the space of many months, been fully investigated by that committee, that the confirmation of the terms mutually agreed upon would follow as a

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matter of course. Had not your Committee thoroughly examined their plans and propositions in competition with these 40 or 50 other schemes referred to them by your Board, my friends would have been willing, nay, even glad, to stake the merits of their scheme against any competition that could have been invited. They feel, however, that on consideration your Board must think that the time for such an ordeal has gone by, and that it would almost amount to a breach of confidence were other parties with a knowledge of our plans and propositions to be invited to compete with us. These expectations have induced them at great expense to make their final surveys and working drawings, so as to enable them to lose no time in obtaining and preparing the land in readiness for the completion of your mains.

They beg me also to state that in their first communication with your Committee the following sentence will be found, showing that they always saw the importance, and, as they thought, fairness of the step, they asked your Board to take in their letter of the 18th instant:—

"Should our offer be favourably entertained, we shall feel obliged by your not making your decision public, as we shall then labour under greatly increased difficulties in completing our arrangement for the land."

And again, in the further particulars of their scheme, demanded by your Main Drainage Committee, 5th April 1859, the following sentence to the same effect will be found:—

"As the chances of being able to apply the sewage successfully will be greatly impeded by an arrangement of this nature being made public before the land is legally secured, it is hoped your Board will feel that it is inexpedient to give this matter any unnecessary publicity for the space of six months."

Should, however, your Board be of opinion that any public advantage could arise from a further discussion on the subject, they have directed me to be in attendance at your meeting next Friday, to answer any inquiries that members who have not been present at previous discussions may wish to put. At the same time they feel that as commercial men, your Board must perceive there is nothing unusual, or but what each of you individually would wish had you to secure so large an area of land for public or private uses, their sole objection to publicity being that the terms may be so raised against them as to render it impossible for them to try their experiment with any reasonable hope of ultimate remuneration.

The land, once secured at a fair rate, they will court the widest publicity.

On my own part, whilst thanking individually each member of your Board for the kindness and consideration shown me, allow me to add, that had I contemplated at such a stage of the proceedings the whole matter would be re-opened, I should have hesitated ere I devoted time, capital, and energy to the prosecution of a subject which I have studied so many years, and which I hold to be of national importance.

I am, &c.
(signed) *Charles H. Roberts.*

John Pollard, Esq.

London Sewage Utilisation Company's
Temporary Offices,
1, Gray's Inn Square,
Gentlemen, 5 July 1860.

The Directors of the London Sewage Utilisation Company (Limited) authorise me to deliver to you the accompanying tender on behalf of the Company for the sewage of London. I am further directed to acquaint you that this Company has been incorporated with a view to carry out the plan promoted by Mr. C. H. Roberts for the application of sewage to land by irrigation.

The proposals of Mr. Roberts combine all the details of the system he advocates, and the data upon which that system is based; they have been laid before your Board for many months, and have been, as the Directors are informed, favourably reported on by your Main Drainage Committee; the Directors therefore do not think it necessary that I should on this occasion re-enter upon such details.

Mr. Roberts' plans require to be further tested to prove practically that they contain commercially available elements.

This Company has in consequence, been formed with an experimental capital of 30,000 *l.*, in the first instance, which the Directors are of opinion will adequately develope the system over a sufficient area of land in proximity to the main outfall channels of the Board of Works. It is estimated that to employ the whole of the London sewage a capital of not less than 500,000 *l.* will be necessary. This Company has taken power to increase its capital, and should the expectations of success entertained by the Directors be realised, they feel assured that the additional capital would be raised without difficulty.

I have, &c.
(signed) *George Townsend,*
Secretary.

To the Metropolitan Board of Works.

The London Sewage Utilisation Company (Limited) tender to receive from the Metropolitan Board of Works all such sewage to be conveyed on the north side of the River Thames through the main outfall channels, having their outlet at Barking Creek, as the Company shall require, and be able to employ, for the preliminary term of two years, to be computed from the time when such main outfall channels shall regularly deliver sewage upon the following terms and conditions, viz.:—

That the Company shall pay to the said Board of Works for such sewage a rental of 5 *l.* for each of the said preliminary two years.

That during such two years the Metropolitan Board of Works shall fully empower the Company to draw and take away such sewage at all such parts of the main outfall channels between the River Lea and Barking Creek as the Company may require, with liberty for the Company to open such communication with or into such main outfall channels as the Company shall deem necessary, but the same being nevertheless subject to the sanction and approval of the engineer for the time being to the Metropolitan Board of Works.

That, at the expiration of such term of two years, should the Company so desire, and give to the Metropolitan Board of Works three months' previous written intimation thereof, the Metropolitan Board of Works shall grant to the Company all such sewage conveyed by the main outfall channels, both on the north and south sides of the River Thames (except the Western District sewage) as the Company shall require, for the term of 21 years from the expiration of the preliminary two years, with all full and necessary powers for receiving and taking the same at a like rent of 5 *l.* for each year.

That at the termination of the said term of 21 years, and of three months' prior notice by the Company of their desire to extend such term, the Metropolitan Board of Works shall grant to the said Company such sewage for an additional term of years, and that such term, and the rent or royalty to be then paid by the Company, shall be then agreed upon by the Metropolitan Board of Works and the Company; and in case of difference, the same shall be submitted to the determination of the President for the time being of the Society of Civil Engineers, or, if none, then of some independent civil engineer, to be appointed by agreement between the Metropolitan Board of Works and the Company, or by the Board of Trade in case of difference.

That in estimating the amount of such rental or royalty, and the length of such future term, due consideration in favour of the Company is to be given to the originally speculative nature of the undertaking, and to the outlay made by the Company in carrying it into effect.

That in the event of the Company desiring at any time to relinquish the sewage, the Directors shall be at liberty to do so, on giving to the Metropolitan Board of Works two years' prior notice in writing of such desire.

That the Metropolitan Board of Works shall, at the request of the Company, do and execute all acts necessary to give due effect to this tender, and to facilitate the undertaking of the Company; and if any legislative enactments shall be requisite for that purpose, the Metropolitan Board of Works will concur therein at the request and cost of the Company.

By order of the Directors,
(signed) *George Townsend,*
Secretary.

The 5th day of July 1860.

Metropolitan Board of Works,
1, Greek Street, Soho,
Dear Sir, 30 July 1860.

I SEND herewith, in accordance with your request, copy of the Draft Agreement for use of sewage.

Truly yours,
(signed) *John Pollard.*

C. H. Roberts, Esq.,
55, Mornington Road, Regent's Park.

ARTICLES OF AGREEMENT made this day of , 18 , between the Metropolitan Board of Works of the one part, and the Company of the other part.

WHEREAS the said Board, in exercise of the powers conferred upon them by the Act of the 18 & 19 Vict., c. 120, for the better Local Management of the Metropolis, and the Act of the 21 and 22 Vict., for amending that Act, and extending the powers of the said Board for the purification of the Thames and the Main Drainage of the Metropolis, are now engaged in constructing and executing, or have prepared and approved plans for the construction and execution of certain sewers and works of Main Drainage and Interception, and the outfall channels of certain of the said sewers and works are intended to terminate at or near Barking Creek, on the north side of the Thames, and at or near Crossness Point, on the south side of such river: And whereas the said Company have represented to the said Board that the Company can advantageously and profitably apply sewage matter, and at the same time relieve the Board of heavy charges and expenses which they would otherwise be put to in the construction of reservoirs, deodorisation, filtration, and disposal of sewage matter, and in other respects, and the said Company have made application to the said Board to grant to the Company, subject to the conditions afterwards mentioned, the use of the sewage conveyed through certain sewers vested in the said Board: Now these presents witness that the said Board do hereby agree with the said Company, that the Company shall have full permission and liberty to take and use so much of the sewage conveyed through the said outfall channels as the said Company shall apply for, for and during the preliminary term of two years, to be computed from the time when such outfall channels shall be completed, and shall begin regularly to deliver sewage, with full liberty to take all or any part of the said sewage at any place or places between the River Lea and Barking, on the north side of the Thames, and

and Crossness Point, on the south side of such river, as the said Company shall specify and determine, and the said Board shall permit and approve; and for that purpose to make all proper and necessary communications with the said outfall channels between the points aforesaid, subject to the like permission and approval of the said Board on payment by the said Company to the said Board of the rent of *l.* per annum, during the said preliminary term of two years: And it is hereby further agreed between the said parties hereto, that at the expiration of the said preliminary term of two years, the said Board shall, in case the said Company shall be desirous of obtaining, and shall apply for an extension of the said term, grant to the said Company a similar license and permission to take and use such sewage for a further term of 21 years, to be computed from the expiration of the said preliminary term of two years on the like terms and conditions, at the rent of *l.* per annum during each and every year of the said extended term. And the said Company do hereby covenant and agree with the said Board, that all works which shall be executed, and all operations which may be performed by them, shall be carried on and conducted in such a manner as not to create a nuisance, and in case any nuisance shall be created, or shall arise by reason or in consequence of any such works or operations, and any prosecution, inquiry, or proceedings shall be taken or directed by one of Her Majesty's Principal Secretaries of State, under or by virtue of the Metropolis Local Management Act Amendment, 21 & 22 Vict., c. 104, for the abatement of any nuisance arising from or occasioned by any such works or operations, and such Secretary of State shall order any proceedings to be taken to ensure the prevention or abatement of such nuisance, the said Company agree to give effect to such order; and in default the said Company shall, upon receiving three days' notice in writing from the said Board, cease and discontinue their

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their works and operations; and it shall be lawful for the said Board to put an end to and determine the said license and permission to take and use the said sewage and to cut off or stop up all and every communication between their works and the sewers of the Board without compensation to the said Company.

And the said Company do hereby further agree that, in case of any prosecution, action, suit, or other proceeding being brought or taken against the said Board, in consequence of any nuisance by reason of the works and operations of the said Company, or any loss, damage, or injury by reason or in consequence of such works or operations, they shall hold harmless and indemnify the said Board therefrom, and forthwith pay the said Board all costs, charges, damages, and expenses which they shall or may have incurred or been put to by reason or in consequence thereof. And it is hereby declared that the grant hereby made is not intended to extend to the granting any higher power affecting any of the rights, privileges, powers, or authorities vested in the Metropolitan Sewage Manure Company by an Act of the Session holden in the 9th and 10th years of Her Majesty, intituled, " An Act to incorporate a Company by the name of the Sewage Manure Company," or an Act of the Session then next following, intituled, " An Act for enabling the Metropolitan Sewage Manure Company to alter the line of their works, and for other purposes," subject to the restrictions of the Act of the 18th and 19th Vict. for the better Local Management of the Metropolis. In witness, &c.

Note.—The above is the agreement as finally settled by Counsel.

London Sewage Utilisation Company
(Limited), Temporary Offices,
1, Gray's Inn-square, W.C.,
31 July 1860.

Gentlemen,

I AM desired to inform you that the Directors of the London Sewage Utilisation Company have instructed Mr. Roberts, and their solicitor, Mr. Gosling, to attend at your meeting this afternoon to finally arrange terms for the concession of the sewage.

I have, &c.,
(signed) *George Townsend.*

To the Members of the
Main Drainage Committee.

London Sewage Utilisation Company
(Limited), Temporary Offices,
1, Gray's Inn-square, W.C.,
London, 14 August 1860.

Gentlemen,

THE Directors of the London Sewage Utilisation Company, deeply regretting the cause which led to the postponement, at your last meeting, of the consideration of the sewage concession, trust that your Committee will this day resume the discussion of the matter with a view to its final settlement before the recess. In order to facilitate this result, the Directors have instructed Mr. C. H. Roberts to be in attendance at Greek-street.

I have, &c.
(signed) *George Townsend.*

To the Members of the
Main Drainage Committee.

London Sewage Utilisation Company
(Limited), 18, New-street,
Spring Gardens, S.W.,
London, 15 December 1860.

Sir,

AT a meeting of the London Sewage Utilisation Company, it was resolved that I should request you to receive a deputation from their Board.

I trust, therefore, that you will favour me with an intimation as to the day next week that it may be convenient for you to receive the deputation.

I have, &c.
(signed) *George Townsend,* Secretary.

John Thwaites, Esq.,
Chairman of the
Metropolitan Board of Works.

Metropolitan Board of Works,
17 December 1860.

Sir,

THE Chairman will be happy to receive the deputation referred to in your note of 15th instant on Wednesday next, at 11.

I am, &c.
(signed) *E. Cresy.*

G. Townsend, Esq.

London Sewage Utilisation Company
(Limited), 18, New-street,
Spring Gardens, S.W.,
London, 18 December 1860.

Sir,

I AM able to supply the information you required this morning respecting the date of the registration of the London Sewage Utilisation Company. It was registered June 2, 1860.

I have, &c.
(signed) *George Townsend,* Secretary.

J. Thwaites, Esq.

LONDON SEWAGE.

Metropolitan Board of Works,
1 August 1861.

Sir,

I AM instructed to inform you that a meeting of the Main Drainage Committee of the Metropolitan Board of Works will be held at this office on Tuesday next, the 6th instant, at 2 o'clock p.m., when the tender of the London Sewage Utilisation Company for a concession of the sewage of London will be further considered, and I am to request the favour of your attendance on that occasion.

I am, &c.
(signed) *John Pollard,*
Clerk of the Board.

George Townsend, Esq., Secretary,
London Sewage Utilisation Company,
1, Gray's Inn-square.

LONDON SEWAGE.

Metropolitan Board of Works,
25 October 1861.

Sir,

I AM instructed to inform you that a meeting of the Main Drainage Committee of the Metropolitan Board of Works will be held at this office on Tuesday next, the 29th instant, at 12 o'clock at noon, when the tender of the London Sewage Utilisation Company for a concession of the sewage of London will be further considered, and I am to request the favour of your attendance on that occasion.

I am, &c.
(signed) *John Pollard*,
Clerk of the Board.

George Townsend, Esq.,
Secretary of the
London Sewage Utilisation Company,
18, New-street, Spring Gardens.

London Sewage Utilisation Company, (Limited.)
Offices, 18, New-street, Spring Gardens,
Sir, London, 29 October 1861.

Your letter of the 25th instant only reached me late yesterday evening, as it was addressed Gray's Inn Square, instead of as above.

I have, &c.
(signed) *George Townsend*,
John Pollard, Esq. Secretary.

Metropolitan Board of Works,
Spring Gardens,
Dear Sir, 16 November 1861.

I am directed to inform you that your communication in reference to the sewage of the metropolis, together with others of a similar nature, having been under the consideration of the Committee to whom the subject has been referred, they have arrived at the conclusion that before coming to a final decision with respect to any of them, it would be necessary that they should have every possible opportunity for testing the efficiency of the scheme in an engineering and chemical point of view, and for satisfying themselves that the requirements of the Act of Parliament relating to the subject shall in no way be infringed by the creation of a nuisance in carrying out the works.

With this view I am to request that you will be good enough to supply a map and sections, showing the area of the intended operations, the levels of its surface, and the lines, levels, and sizes of the intended aqueducts, indicating the various kinds of surface soil with which it is proposed to deal, and showing in detail what mode of subsoil drainage it is intended to adopt, if any, with the size, depth, and inclination of the several proposed lines of drainage, together with descriptions and particulars of the pumping power to be employed, the number of lifts, and the nature of the outfall.

Also, a statement showing the manner in which it is proposed to work the scheme, what kind of powers will be taken for dealing with the land to be operated upon, and how owners and occupiers are to be treated with; what quantity of sewage will be taken up daily, over what quantity of land it will be distributed, what depth it will occupy, over what area of land; and if it be intended to employ varying quantities at different seasons, what that variation will be.

Also, a full statement of the means of deodorisation, if any, the chemical agents employed, and the details of their mode of application, and what arrangements, if any, it is proposed to make for dealing with the heavy deposit.

Also, an estimate showing, separately, the cost of the engines and pumps, if any, the conducting pipe or sewer, the distributory and deodorising apparatus, and the subsoil drainage, together with the annual working expenses of each of these three heads of expenditure.

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I am, &c.
(signed) *John Pollard*,
Clerk of the Board.

George Townsend, Esq.,
Secretary London Sewage Utilisation
Company,
18, New-street, Spring Gardens.

London Sewage Utilisation Company (Limited),
Offices, 18, New-street, Spring Gardens, S.W.,
Sir, London, 9 January 1862.

The Directors of this Company have been informed that a proposition from the Honourable William Napier and Mr. William Hope for a concession of the sewage of the northern area of the metropolis was submitted to the Board in the course of the last month, and that the Board is urged to make an immediate grant to them of such sewage.

I am, in consequence, instructed by my Directors torem ind you of the negotiations which have been long pending with the Board for a grant to this Company of the sewage in question upon the anticipated success of which the Company was established, and great expenditure has been incurred; and I am directed to urge upon your Board the just claim of this Company to be heard in support of their proposition before any concession of the sewage is made by the Board.

I am, &c.
(signed) *George Townsend*,
J. Thwaites, Esq., Secretary.
Chairman of the
Metropolitan Board of Works.

Metropolitan Board of Works,
Spring Gardens,
Dear Sir, 20 January 1862.

The Board have adjourned the consideration of the question as to granting a concession of the sewage of London until Friday, the 7th February next, and directed the communications read on Friday last to be printed. I beg to enclose you copy of the same for the information of the parties interested in your application.

I am, &c.
(signed) *John Pollard*,
Clerk of the Board.

George Townsend, Esq.,
Secretary to the
London Sewage Utilisation Company,
18, New-street, Spring Gardens, S.W.

London Sewage Utilisation Company
(Limited), Offices 18, New-street,
Spring Gardens, London,
Sir, 13 February 1862.

At a meeting of the Directors of this Company it was unanimously resolved to urge upon your Honourable Board that the time had now arrived for you to complete the arrangements for the concession of the sewage, according to the terms of the Draft Agreement prepared by our solicitor and placed in the hands of your solicitor for examination and approval.

I am further instructed to remind you that this

App. No. 24. Company has now been negotiating with your Board for more than three years; that at various meetings of your Main Drainage Committee our plans and surveys, accompanied by our proposals, were laid before them and fully discussed; and that this Company was formed and registered on its being suggested that your Board could not satisfactorily deal with private individuals, and in the expectation that the concession would be granted subject to some trifling alteration of terms.

The Directors of this Company believe that your Board will, in justice, admit that they have a prior claim to any scheme that may have been suddenly brought under your notice, and that the advantages they offer are more worthy of your favourable consideration.

I have, &c.
(signed) *George Townsend*,
Secretary.

John Thwaites, Esq.,
Chairman of the
Metropolitan Board of Works.

Metropolitan Board of Works,
Spring Gardens,
18 February 1862.

Sir,

At the meeting of the Metropolitan Board held on Friday last, the subject of the several propositions for taking the sewage of London was brought under the notice of the members, and I laid before them your letter of the 13th instant, urging upon this Board a favourable consideration of the scheme of the London Sewage Utilisation Company (Limited); but the attention of the Board having been called to the fact of the intention of Government to acquiesce in the appointment of a Committee of the House of Commons to inquire into the best means of utilising the sewage of the cities and towns of England, with a view to the reduction of local taxation and the benefit of agriculture, they adjourned the further consideration of the matter until that Committee shall have made their report.

I am, &c.
(signed) *John Pollard*,
Clerk of the Board.

George Townsend, Esq., Secretary, London
Sewage Utilisation Company (Limited),
18, New-street, Spring Gardens, S.W.

London Sewage Utilisation Company
(Limited), Offices,
18, New-street, Spring Gardens, S.W.,
London, 24 November 1862.

Sir,

I am desired by the Directors of this Company to request that you will bring the accompanying communication under the notice of the Board on Friday next.

I have, &c.
(signed) *George Townsend*,
Secretary.

John Pollard, Esq.,
Clerk of the Metropolitan Board of Works.

London Sewage Utilisation Company,
(Limited), Offices,
18, New-street, Spring Gardens, S.W.,
London, 24 November 1862.

Gentlemen,

I am directed by this Company to remind your Board that in your last communication (No 231) dated 18th February, in reply to their application of 13th February, you state that the question of granting the concession for the London sewage had been postponed until the Committee appointed by the House of Commons to investigate the subject of Sewage Utilisation should have terminated their labours and presented their report. That report will now be issued in a few days, and as there are several new members on your Board, the Directors of this Company beg most respectfully to urge that they have been before your Board since 1858; that the Company's engineer, Mr. Brunlees, who was in attendance on your Main Drainage Committee, at their desire laid the plans and surveys before your engineer, Mr. Bazalgette; that after repeated interviews and full inquiry before your Main Drainage Committee, your Board was on the point of granting them the concession, and that, by the express desire of your Board, a Draft Agreement was prepared by the Company's solicitors. This document having been placed in the hands of the solicitor to your Board, was by him submitted to counsel. Having advanced thus far, one of the members of your Board moved that, before concluding the business, it would be advisable to advertise in the principal European journals for tenders, and a few months' delay was granted for this purpose, which produced no better offer than that made by this Company.

I am also desired to point out that this Company was formed and registered on its being suggested that your Board could not satisfactorily deal with private individuals, and in expectation that the concession would be granted, subject to some trifling alteration of terms.

As the immense works required for the main drainage of the metropolis are now in an advanced stage, one portion thereof being sufficiently forward to enable this Company, were the concession granted, to deal with the sewage, the Directors trust that your Board will shortly complete the arrangements for some time held in abeyance.

I am further desired to say, in conclusion, that the second report of the Commission to inquire into the best mode of distributing the sewage of towns and applying it to beneficial and profitable uses, fully confirms the practical nature of the plans so frequently brought under the notice of your Board by Mr. Crompton Roberts on behalf of this Company.

I have, &c.
(signed) *George Townsend*,
Secretary.

The Metropolitan Board of Works.

London Sewage Utilisation Company
(Limited),
Offices, 18, New-street,
Spring Gardens, S.W.,
London, 7 May 1863.

Gentlemen,

In reply to your advertisement inviting, for the second time, tenders for the utilisation of the sewage of the metropolis, I am desired by the Directors of this Company to state that as they have, in the years 1860-61 and 1862, spent considerable sums of money and devoted much valuable time in uselessly trying to induce your Honourable Board to accept their proposals for the sewage of the northern area then laid before you (the negotiations for which having been commenced immediately your Board decided on the system for the main-drainage), they cannot in justice to themselves go over the same ground again.

Their proposals must be fresh in your recollection, and should the tenders or proposals now submitted to you by others be less advantageous to your Board, they will be glad to be placed in communication with your engineer or any Committee you may appoint.

I have, &c.
(signed) *Geo. Townsend*,
Secretary.

To the Metropolitan Board of Works.

London, 29, Austinfriars,
Sir, 23 November 1859.

I beg to inform you, for the information of your Honourable Board, that I am prepared to enter into a negotiation for the whole of the sewage of London for a term of 100 years. The time appears to have arrived for applying the sewage of our towns to fertilise our fields instead of polluting our fair streams, and if your Honourable Board will agree to grant me a concession of the whole of the London sewage for the above term, from the support I am offered from various parts of the country, there will be no difficulty in applying the sewage of London to the benefit of the whole community.

The terms I beg leave to propose for the consideration of your Honourable Board are as follows:—

First. That a concession of the whole of the sewage of London be granted to me for a term of 100 years.

Second. That the main drains be constructed as at present intended by your Honourable Board.

Third. The company for applying the sewage to erect all the necessary machinery for pumping from the new main intercepting drains, and convey it to the agricultural districts to be used as manure.

Fourth. That from the revenue derived from the sale of the (manure) sewage the proprietors of the company shall be entitled to receive 7½ per cent. per annum on the outlay of their capital; and all proceeds beyond the above rate to be equally divided by your Honourable Board and the proprietors for the benefit of the ratepayers.

Trusting this proposal will meet the approbation of your Honourable Board,

I have, &c.
(signed) *Geo. Shepherd*, C.E.

The Secretary the Honourable
the Metropolitan Board of Works.

Metropolitan Board of Works,
Sir, 14 January 1860.

By direction of the Chairman I have to inform you that the Main Drainage Committee will, on Tuesday next, proceed to consider your letter in reference to the use of the whole of the sewage of London.

This Committee meets at two o'clock, and your question stands early on the agenda paper.

I am, &c.
G. Shepherd, Esq., (signed) *E. Cresy*.
29, Austinfriars.

29, Austinfriars, E.C.,
Sir, 17 January 1860.

I found your letter of the 14th inst. at my office this morning, informing me the Committee would meet in reference to my letter on the sewage of London. I have been laid up for the last week with a cold, and unable to attend to business, which prevented me being present at Greek-street at the time named in your letter. I should feel obliged if you would favor me with the views of the Committee on my proposal. I should be most happy to attend at any future time.

I am, &c.
E. Cresy, Esq. (signed) *Geo. Shepherd*.

Metropolitan Board of Works,
Sir, 21 January 1860.

The Chairman has directed me to inform you that the Main Drainage Committee will, on Tuesday next, proceed to the consideration of your letter on the use of the sewage of London, and that they desire your attendance at this office at two o'clock, to afford any explanations which may be required.

I am, &c.
G. Shepherd, Esq., C.E. (signed) *E. Cresy*.

London, 29, Austinfriars, E.C.,
Sir, 17 March 1860.

I had the honour of addressing you on the 23d November 1859, in reference to the concession of the sewage of London for the term of 100 years.

I beg to state, for the information of your Honourable Board, I am now in a position to make final arrangements with the Board for this concession.

I am also very anxious to have this matter arranged as early as possible, in order to commence the requisite surveys for laying down the necessary machinery for the complete distribution of the sewage in the agricultural districts.

But, instead of 100 years, the concession to be granted for a term of 50 years, in the first instance; conditions as follows:—

That from the revenue derived from the sale of the sewage in the agricultural districts, the company shall be entitled to a preference of seven-and-a-half per cent. per annum on their capital for the first 50 years; and all profits above the seven-and-a-half per cent. to be equally divided between the Board of Works and Company.

At the expiration of the 50 years the Company to receive a preference of five per cent. per annum on their capital, and the surplus profits to be divided as before mentioned.

Your Honourable Board will please bear in mind it will take some years before the use of the sewage becomes general, even after it is placed at the disposal of the agricultural community.

Trusting these terms will meet the approbation of your Honourable Board,

I have, &c.
(signed) *Geo. Shepherd*, C.E.

The Secretary
the Honourable the Metropolitan
Board of Works.

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London, 29, Austinfriars, E.C.,
31 March 1860.

Sir,

I HAD the honour of addressing you on the 17th instant in reference to the proposed concession for the sewage of London. I am most anxious to learn the opinion of your Honourable Board on this subject.

I have, &c.
(signed) *Geo. Shepherd*, C.E.

The Secretary
the Board of Works.

P.S.—Having received the support of many influential gentlemen, I do not wish this matter delayed.

Metropolitan Board of Works,
3 April 1860.

Sir,

THE communication to which you allude in yours of the 31st March last relative to the concession of London sewage, has been referred to a Committee of the whole Board, and will be presented to the next meeting, which will take place immediately after Easter.

I am, &c.
(signed) *John Pollard*,
Clerk of the Board.

Geo. Shepherd, Esq., C.E.
29, Austinfriars, E.C.

London, 29, Austinfriars, E.C.,
7 April 1860.

Sir,

I AM obliged by your esteemed favour of the 3d instant, in reference to the concession of the sewage. I beg to inform you I am very anxious to have this question settled as early as possible, as new political agitations or complications may commence any moment, which may set this and every other question of public works aside for years to come.

With reference to the statement in the *Times* on the perchloride of iron for deodorising the sewage, I beg your Honourable Board clearly to understand that although Baron Liebig mentioned the perchloride of iron in his letter to Mr. Ellerman, he neither spoke for it or against it, nor had he known even that your Board had any idea of using it. In fact he is of the same opinion as myself on this subject, that the proper place for the sewage is to apply it to the land, and that all other attempts to get rid of it will be found abortive, and all attempts at deodorisation only expensive failures.

I am, &c.
(signed) *Geo. Shepherd*, C.E.

John Pollard, Esq.

London, 29 Austinfriars, E.C.,
16 April 1860.

Sir,

I HAVE been informed by my friend, Mr. Mechi, your Board intend to advertise for tenders for the sewage of London. If this is the case, I fear my friends and supporters will not think it worth their while to take any further trouble in the matter, as your Board may be induced to let out the sewage (if any party applies for it) in small quantities to be distributed over small areas. Such a system, where it has been attempted, has only ended in failure, and, if attempted again, will only have the effect of setting aside any general plan of applying the sewage for years to come at a ruinous expense to the already oppressed ratepayers. I am now ready, if we can come to terms, to take the whole of the sewage of London on the terms I have already proposed. If we are successful the ratepayers will be relieved from the burdens and expenses of constructing reservoirs and deodorising works, &c., and lawsuits with the inhabitants of Erith, Gravesend, and elsewhere; and the ratepayers may ultimately get an annual revenue from the sewage.

If we fail we shall lose our money, and the ratepayers will only be in the position they now are, only that the real value of the sewage will have been ascertained, whether it is good for anything or not.

No sane person for a moment could offer a farthing for it, and considering the great expense it will take to put any scheme into operation for distributing the sewage, I think your Board ought to guarantee 5 per cent. on, say, one million, to try the experiment.

But if your Board accept the terms I have proposed it will convince the ratepayers they are anxious of relieving the inhabitants of London of an intolerable nuisance; at the same time it will induce parties to test its value for agricultural purposes.

I can assure your Board if they grant this concession, the ratepayers will look on it as one of their best and most popular acts. If delayed, and my friends give it up, I have no doubt a great public clamour will be raised against the Board.

I am, &c.
(signed) *Geo. Shepherd*, C.E.

The Secretary
the Board of Works.

P.S.—I will do myself the honour of attending at the Office of Works to-morrow, trusting the Board will grant me an interview.

London, 29 Austinfriars, E.C.,
18 April 1860.

Sir,

REFERRING to our conversation yesterday, in reference to the concession for the sewage of London, I beg most respectfully to state, for the information of your Honourable Board, that we agree to take on ourselves all the liabilities in reference to and every nuisance we may cause in applying the sewage to the land, and also for any damage we may do to property of every kind; and to relieve the Board of Works from the expense of all lawsuits, injunctions, and other legal expenses, as far as the carrying out of our own works are concerned.

I think the names of my supporters will be an ample guarantee that all will be done, as far as they are concerned, to make the undertaking successful, and to relieve the inhabitants of London from the intolerable nuisance the sewage causes.

Our works for the distribution of the sewage will take at least three years to complete; and, if the concession can be arranged without delay, as our works progressed, we could take the sewage from the new main sewers; and the two systems, the drainage, and application of the sewage for agricultural purposes, would come into operation together; and by the time the new main drains are completed our experiments would have been completed, and our works complete for the distribution of the sewage also, which would save the ratepayers

payers the expense of the pumping engines, reservoirs, deodorizing works, &c., to say nothing of the litigation with the various towns on the banks of the Thames.

I most respectfully beg to suggest that it is important to get all the preliminaries arranged, if possible, without delay, as I fear, if we are not met in a liberal spirit by the Board, my friends will get impatient, and the whole affair come to nothing.

I am, &c.
(signed) *Geo. Shepherd*, C.E.

The Secretary,
the Honourable Board of Works.

London, 29, Austinfriars, E.C.,
Sir, 21 April 1860.

I HAVE the honour to enclose a copy of the suggestions for the proposed concession for the sewage of London, as I have now got this matter in good working order. I trust the Board of Works will meet my supporters in this affair with the spirit of liberality this matter requires. We ask nothing from the Board; but what they intend to throw away, if they can, we do not even propose to alter any one of your plans of the new system of drainage; only if the sewage is considered at once we may save the ratepayers a large sum of money in constructing works which may not be required.

Trusting these matters will soon be arranged, before my friends and supporters get tired of waiting, and before any new political agitations disturb the State of Europe,

I am, &c.
(signed) *Geo. Shepherd*, C.E.

The Secretary,
the Honourable Board of Works.

SUGGESTIONS for the Proposed Concession of the Sewage of London.

THE following suggestions are most respectfully submitted to the Honourable the Board of Works, in reference to the proposed concession of the Sewage of London, for the application of the same for agricultural purposes.

First. That the Honourable the Board of Works grant a concession of the whole of the Sewage of London to me for a company on the terms as follows:—

Second. That the new intercepting sewers be constructed as at present intended, by the Honourable the Board of Works. And the company take the sewage from the new sewers at such places as may be mutually agreed between the Honourable the Board and the company.

Third. That for the purpose of distributing the sewage into the agricultural districts, the company undertake to erect all the necessary machinery for pumping the sewage from the sewers. The construction of the reservoirs, and all other works for the complete distribution of the manure in the various localities for agricultural purposes.

Fourth. The company undertake the liabilities of all legal proceedings in reference to any, and every nuisance they may cause in applying the sewage to the land, and also to pay for any damage they may do to property of every kind; and also relieve the Honourable the Board of Works from all legal and other expenses, so far as the carrying out of the company's works for the distribution of the sewage is concerned.

Fifth. The concession to be granted in the first instance for a term of 50 years as follows:—That from the revenue derived from the sale of the sewage in the agricultural districts, the company to be entitled on all occasions to a preference of seven-and-a-half per cent. per annum on their capital employed for constructing the necessary works and working expenses of the same, in distributing the manure over the agricultural districts; and all proceeds beyond the seven-and-a-half per cent. per annum to be equally divided between the Honourable the Board of Works for the benefit of the ratepayers and the company.

Sixth. That at the expiration of the 50 years, the company receive a preference of five per cent. per annum on their capital, and the surplus profits to be divided as in the preceding paragraph.

Seventh. That the company commence their works for the distribution of the sewage as soon as possible after the concession is granted, or as soon as the necessary powers can be obtained from Parliament, and the requisite land for constructing the works.

Eight. That the Honourable the Board of Works give every possible facility to the company for erecting the necessary pumping engines and other works the company may require in carrying out their operations.

Ninth. That all disputes which may arise between the Honourable the Board of Works and the company, to be settled by arbitration.

Tenth. That if the concession be granted, the solicitors and engineers of the contracting parties meet at an early day to settle all minor points not herein mentioned.

(signed) *Geo. Shepherd*, C.E.

21 April 1860.

Gentlemen, 24 April 1860.

I SHALL be most happy to answer any questions your Honourable Board may now wish to put to me in reference to my letters and communications already sent in.

I am, &c.
(signed) *Geo. Shepherd*, C.E.

To the Honourable the
Board of Works.

29, Austinfriars, E.C.,
Sir, 4 July 1860.

I BEG leave most respectfully to inform your Honourable Board I have carefully considered your advertisement in reference to the sewage of London, but I cannot but repeat my offer for the sewage, the terms of which are already in your possession. As it will take a large amount of capital to apply the sewage for agricultural purposes, there is one clause more, for our protection, will be desirable, namely:—As we take all the responsibility of any nuisance we may cause, it is but right that we should ask the full and free control of the sewage, without let or hindrance on part of the Board of Works; and as it is the intention of the company to carry the sewage beyond the limits likely to be required for building purposes,

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poses, before it is applied for the purposes of irrigation, consequently no nuisance will be committed within the jurisdiction of the Board of Works. I may add, it will be desirable to get these negociations settled as soon as possible, as a Bill must be prepared for Parliament for the next Session to enable the company to obtain the necessary lands for their works.

I have, &c.
(signed) *Geo. Shepherd*, C.E.

The Secretary the Honourable the
Board of Works.

29, Austinfriars, E.C.,
Sir, 24 July 1860.

I HAVE the honour to inform you, for the information of your Honourable Board, that, provided the Board will grant me a concession of the sewage of London on the terms proposed in my letters of the 21st April ult., I am prepared to expend the sum of from 20,000 *l.* to 30,000 *l.* for the construction of experimental works at Croydon for applying the sewage of that town for agricultural purposes. The works will be carried out under the superintendence of some of the most experienced agriculturists of the day. As it is desirable to commence the works at Croydon before winter sets in, an early answer to this letter will much oblige.

I have, &c.
(signed) *Geo. Shepherd*, C.E.

The Secretary, the Honourable the
Board of Works.

Metropolitan Board of Works,
Sir, 26 July 1860.

I BEG to acknowledge the receipt of your communication of the 24th inst. on the subject of the sewage of the Metropolis, and to inform you that the same shall be submitted to the Metropolitan Board of Works.

I am, &c.
(signed) *John Pollard*,
Clerk of the Board.

George Shepherd, Esq., C.E.,
29, Austinfriars.

(Private.) 29, Austinfriars, E.C.,
Sir, 28 July 1860.

I HAD the honour of addressing you on the 24th inst. in reference to the concession of the sewage of London. I beg to inform you, for the private information of the Honourable the Board of Works, the names of the gentlemen connected with me in the proposed experimental works at Croydon are:—

The Earl of Ellesmere.
The Earl of Denbigh.
The Lord Calthorpe.
J. H. Langston, Esq., M.P.
R. Benyon, Esq., M.P.
C. Du Cane, Esq., M.P.
W. F. Maitland, Esq., Stanstead Hall, Essex.

I should feel obliged if you will favour me with the opinion of the Board on the subject.

I have, &c.
(signed) *Geo. Shepherd*, C.E.

The Secretary, the Honourable the
Board of Works.

Metropolitan Board of Works,
Sir, 30 July 1860.

I HAVE to acknowledge the receipt of your communication of the 28th inst., enclosing the names of gentlemen connected with you in the proposed experimental works at Croydon, and to inform you that the same shall receive attention.

I remain, &c.
(signed) *John Pollard*,
Clerk of the Board.

Geo. Shepherd, Esq., C.E.,
29, Austinfriars, E.C.

London, 26, Throgmorton-street, E.C.,
Sir, 17 October 1860.

ON the 21st April ult. I had the honour of forwarding certain proposals to your Honourable Board in reference to a concession for the sewage of London; and, on the 28th July ult., I also addressed you and forwarded the names of my supporters for carrying out the necessary works for the distribution of the sewage over the agricultural districts. I should esteem it a great favour if you would inform me when this matter is likely to be brought before the Board.

I have, &c.
(signed) *Geo. Shepherd.*

The Secretary, the Honourable the
Board of Works.

Metropolitan Board of Works,
Sir, 18 October 1860.

I BEG to acknowledge the receipt of your communication of the 17th instant, and to inform you that the same shall be laid before the Committee, to which the matter has been referred.

I am, &c.
(signed) *John Pollard.*
Clerk of the Board.

G. Shepherd, Esq.,
26, Throgmorton-street, E.C.

London, 26, Throgmorton-street, E.C.,
Sir, 30 October 1860.

I HAVE the honour to forward you, for the information of your Board, the prospectus of the Croydon Sewage Irrigation Company. I should feel extremely obliged if the Board will favour me with their views as to the terms proposed by me for the concession of the whole of the Sewage of London. I think the Board will now be satisfied that the matter will now be taken up in earnest on our part. Waiting your reply,

I have, &c.
(signed) *Geo. Shepherd*, C.E.

The Secretary, the Honourable
the Metropolitan Board of Works.

THE CROYDON SEWAGE IRRIGATION COMPANY (LIMITED).

Capital, 30,000 *l.*, in 3,000 shares of 10 *l.* each.
Deposit, 2 *l.* 10 *s.* per Share.

Directors.

The Right Hon. the Earl of Denbigh.
The Right Hon. Lord Calthorpe.
J. H. Langston, Esq., M.P., 143, Piccadilly, and Chipping Norton, Oxfordshire.
R. Benyon, Esq., M.P., 34, Grosvenor-square, and Englefield House, Reading.
C. Du Cane, Esq., M.P., 64, Lowndes-square, and Braxted Park, Essex.
W. F. Maitland, Esq., Stanstead Hall, Essex.

Consulting Chemist.

Baron Liebig, Professor of Agricultural Chemistry.

Engineer.

George Shepherd, Esq., C.E.

Bankers.

Messrs. Prescott, Grote, Cave, and Cave, 62, Threadneedle-street, E.C.

Solicitors.

James Crowdy, Esq., 17, Serjeant's-inn, Fleet-street, E.C.
Robert Arthur Ward, Esq., Maidenhead.

Auditors.

Messrs. Coleman, Turquand, Youngs, and Co., Accountants, 16, Tokenhouse-yard, Lothbury, E.C.

Brokers.

Messrs. Crossley Brothers, 30, Cornhill, E.C.

Secretary, pro-tem.

J. Bowing, Esq.

Offices: 26, Throgmorton-street, E.C.

"The very substance which is pollution to you in one place will be salvation to you in another. The sewage of your towns well bestowed will relieve you from all anxiety and preserve the fertility of your soil, and the strength of your population from impoverishment and decay. We shall thus gather up the fragments and nothing will be lost."—'Times,' 23 December 1859.

The sewage of our towns is now acknowledged by all classes of scientific men and practical farmers to be of the utmost value for manuring our fields, and wherever the sewage has been applied it has greatly increased the fertility of the soil, the rental value of the land being also proportionately augmented (*see* enclosed correspondence and extracts.)

The Company intend to apply the sewage of the town of Croydon to irrigate the land contiguous to that town, on the plan proposed by the Company's engineer, which has received the approbation of the highest agricultural authorities.

By the plan proposed the sewage manure can be supplied over a large area to estates and farms at a rate remunerative to the landed interests, the farmer, and the capital invested.

For this purpose a concession of the sewage of the town of Croydon has been granted to the Company's engineer, for a term of 100 years, and the right of use of the parish roads and land for laying mains and constructing the requisite works, which concession will be assigned to the Company.

The quantity of sewage generated by the town of Croydon averages about 1,500,000 gallons daily (including street washings, gas works, slaughter houses, and other manurial refuse), or about 550,000,000 gallons of rich sewage which, at 60,000 gallons per acre, will irrigate about 9,000 acres of land per annum.

It is proposed to take the sewage as it flows from the town, and pump it into a reservoir situated on an elevation about two miles from the town, from which it will flow to each farm and field by gravitation, and always be at command for irrigation.

The cost of pumping the sewage will be best explained by referring to the cost of pumping the water, with Cornish engines, for supplying the town of Croydon, where 26 cwt. of coal dust, at 13 *s.* per ton, raises 1,000,000 gallons of water 180 feet in 24 hours.

Estimated Cost of Works.

Assuming the sewage to be applied to the above area, from a careful estimate made by the Company's engineer, the cost of laying the sewage mains, constructing the pumping engines, reservoirs for the irrigating 9,000 acres will not exceed 50 *s.* per acre, and the whole of the works can be completed in from four to five months.

	£.
For applying the sewage of Croydon to 9,000 acres of land, at 50 *s.* per acre - - - - - - - - -	22,500
Proposed capital to be raised - -	30,000
Cost of works as above - - - -	22,500
Available surplus for commercial capital - - - - - - - - -	£. 7,500

Revenue to the Company.

It is proposed to supply the farmers with the sewage, *ad libitum*, at the rate of 30 *s.* (or at a cost of 3 cwt. of guano) per acre, thus:—

	£.
9,000 acres, irrigated at 30 *s.* per acre	13,500
Less working expenses and general charges, at 40 per cent. per annum	5,400
	£. 8,100

Which will give a considerable rate of interest per annum.

The Company propose only to lay the sewage mains, and construct the reservoirs, and lay the smaller mains to the most suitable place to supply each farm; the landowners and farmers will have to lay the pipes for irrigation at their own cost. The Company's engineer has devised a plan for this purpose, which will not cost the farmer more than from 8 *s.* to 10 *s.* per acre for his irrigating apparatus.

The Company's engineer will render the farmers all necessary assistance in laying the pipes for irrigating or draining their land.

The Directors feel convinced that this Company will be the pioneer of a general system of utilising the sewage, instead of its polluting our streams. The accompanying extracts from the highest authorites clearly prove that the sewage, when applied to the soil, greatly increases its fertility, and, consequently, the agricultural wealth of the country. Such a consummation as the general use of the sewage as a fertiliser would render England independent of other nations, both for foreign manures, and agricultural produce of every kind.

The present Company is formed under the Limited Liability Act, with a nominal capital of 30,000*l.* in 3,000 shares of 10*l.* Each deposit 2 *l.* 10 *s.* per share.

Application for the remaining shares to be made to Messrs. Crossley Brothers, 30, Cornhill, E.C.; or to J. Bowing, Esq., the Secretary, at the offices of the Company, London, E.C.

Opinions of eminent Agricultural Chemists on the Value of Sewage Manure.

Professor Voelcker, consulting Chemist to the Royal Agricultural College, Leamington:—"I am decidedly of opinion that the sewage may be applied to the land all the year round, and it is well worth the attention of landed proprietors."

R. Grainger, Esq., of the General Board of Health, states:—"There can be no doubt, whether it takes place this year or subsequently, that the application of the sewage of our towns for agricultural purposes will become a realised fact."

Professor Way, Chemist to the Royal Agricultural Society, whose writings on this subject are most numerous, says:—"Recent experiments have shown that we may apply sewage to our clay soils at any period, and in any quantity; that the valuable manurial solutions will remain in the soil, chemically arrested by an all-wise Providence for the use of the plants, and for the ultimate food for man."

Extract from a letter to the referees appointed to consider the plans proposed for the Main Drainage of London, by G. J. H. Gilbert, Esq., P.H.D., F.C.S.—"There cannot be the slightest doubt that the constituents of town sewage, arising from human excrements and other matters have, in themselves, a very high manuring value; indeed the conclusion of Mr. Lawes and myself on this point is that, if the constituents in the sewage of the metropolis could be conveniently applied for the production of corn, they would return somewhat about one-third of the wheat consumed by its population, indirectly, and cumulatively their productiveness would be much greater."

Boussingcault remarks on the assumption that the liquid and solid excrements of a man amount on an average, to only one and-a-half pound daily ($1\frac{1}{4}$ urine and $0\frac{1}{4}$ lb. fœces) and that both, taken together, contain 3 per cent. of nitrogen; thus, in one year, they will amount to 547 lbs., containing 16.41 lbs. of nitrogen—a quantity sufficient to yield the nitrogen of 800 lbs. of wheat, rye, oats, or 900 lbs. of barley."

The documents issued by the general Board of Health, Whitehall, entitled "Minutes of Information collected on the application of Sewer Water and Town Manure to Agricultural Production," deserve the attentive perusal of every one interested in the question.

"About 60 per cent. of the water supplied to London goes into the sewers after it has been used for the various household and other purposes, viz., washing clothes, dishes, cooking utensils, the wash and slops from the bed rooms, water used for cooking, washing the person, &c. In addition to this, there is the wash from the slaughter houses, gas works, manufactories, and various other places too numerous to mention. These 48 million gallons of water, consequently, contain all the soap, soda, potash, fatty matter from every dinner plate and cooking pot, the water used for cooking food of every kind, besides valuable slush of every character from all possible places, all of which contain ingredients of animal and vegetable matter of the highest fertilizing character. From numerous experiments I am convinced that this mass of sewage is eqnal in value to the water closet sewage itself."

"About 12 million gallons of water goes through the water closets, carrying with it into the sewage all the excrements from nearly three millions of human beings, the inhabitants of London. Taking the excrements (fæces and urine) at $3\frac{1}{4}$ pounds daily from each person, this 12 million gallons contains about 9,750,000 lbs, or 4,352 tons of excreta daily in the best state for assimilation with the soil. Therefore, scarcely a gallon of water goes into the sewers which does not contain valuable manure, more or less.

"Such is the composition of the sewage; and, as will be readily understood, it is rich in soda, potash, phosphates of every kind which the land requires for the nourishment and growth of the plants, and in its liquid state is best adapted for assimilation with the soil. (*See* Analysis in Liebig's 'Agricultural Chemistry,' pp. 260, 261."—Mr. Shepherd, C.E.—Speech at the Society of Arts.)

Liebeg, in his "Agricultural Chemistry," at page 179, says:—"The urine of men and animals, subsisting upon flesh and grain, contains alkaline phosphates, while that of animals, living wholly upon grass, is destitute of these salts. The analysis of human excrements, those of birds living upon fish (guano), and the excrements of the horse and the cow, yield conclusive proofs of the nature of the salts contained in them. In the solid and liquid excrements of man and of animals, we restore to our fields the ashes of the plants which serve to nourish these animals. These ashes consist of certain soluble salts and unsoluble earths, which fertile soil must yield, for they are indispensable to the growth of cultivated plants."

On the Manurial Value of the Sewage for Grass Lands.

H. Caunter, Esq., Ashburton, Devon, states:—"As an illustration of the extraordinary effects of sewage water, even in a highly diluted state, I will mention that beautiful valley in Devonshire, immediately below the little town of Ashburton. The stream of water which runs through the place receives all its sewage and the wash of two or three manufactories, and is afterwards, by a well-arranged system, made to irrigate the valley below, for nearly three miles in extent, until it falls into the River Dart. The produce of this valley is perfectly astounding, and no stranger can ever pass along the high road from Ashburton to Buckfastleigh without being at once struck with the luxuriance and abundance of the pasture around him. The average rental is about 6*l.* per acre, but it sometimes lets at fabulous prices, especially in a late cold spring. The last meadow is as good as the first. The water rises on the high moorlands; it is of no use for irrigation, but absolutely injurious to the soil before it receives the sewage or wash of the town. The population of Ashburton does not exceed 2,500 inhabitants. The land not irrigated lets for 20*s.* per acre."

Mr. Thomas Lawrence, Court Farm, Malvern, states:—"Since we have had the sewage on this field we have had five times the quantity of hay we ever had before. We used to mow our clover three weeks before we mowed our hay. Since we have had the sewage we have mowed our hay three weeks before we cut our clover, and the grass ought to have been cut much earlier than it was; it was rotten at the bottom for want of being cut earlier. We now cut our grass for hay three times in the year instead of once, and have a good pasture for our cattle until very late in the winter."

Mr. Morrison, farmer, of Malvern, states:—"Since I have had the sewage on my farm I get five times the quantity of hay I ever had before. I cut my first crop of grass on the 1st of May, the second crop is ready to cut again before my neighbours cut their first and only crop of grass for hay."

"The sewage and wash of the town of Mansfield has been applied to irrigate the fields in the neighbourhood of that town; previous to the application of the sewage the land let at 3*s.* per acre per annum. The same land now lets at 12 *l.* per acre per annum; value 11 *l.* 17*s.* per acre per annum in favour of the sewage."

The Royal Commissioners on the sewage describe the works at Edinburgh as follows:—"The Edinburgh meadows afford the largest instance in Great Britain of the application of sewage by gravitation. The operation has been carried on over some of those meadows for more than 60 years. They comprise in all about 325 imperial acres, and receive the sewage of about one half the city of Edinburgh; that is, of something like 80,000 people. The crops, almost entirely of grass, are of the richest description, as may be judged from the fact that they are sold by auction every year at an average of from 20 *l.* to 30 *l.* per imperial acre. Of the value of the sewage application in this case no doubt can be raised. The works were undertaken in the first instance solely with the view to profit, and they have answered so well that the meadows, some portions of which were formerly barren sea sand, are now a very valuable property."

The sewage of the town of Watford is applied to the estate of the Right Honourable the Earl of Essex, at Cassiobury Park. The noble earl speaks as follows of its manurial value on his grass lands:—"During the winter, from October to January, or longer, I apply it to meadows for hay, two dressings per acre, with about 50,000 gallons, *i.e.*, 225 tons. I have done this now two winters, and the increase of hay, both in quantity and quality, is most extraordinary. It seems especially to thicken the bottom wonderfully, bringing up abundance of clover. I think my produce of cut grass this year, when the cuttings are over and accounts made up, will not be less than 46 tons per acre. The year before last I kept 34 bullocks all the summer with as much as they could eat from seven acres. They had some cake also, and were well fattened. This year I have 14 bullocks and eight horses consuming it. The former are fattening beautifully without any other food."

The Manurial Value of Sewage for Italian Rye Grass and Potatoes.

James Archibald Campbell, Esq., Rugby, in a letter to J. Hitchman, Esq., Leamington, states:—"The crop (Italian rye grass) at Edinburgh is sown in August, and one cutting is sold in the autumn at 4 *l.* per acre; the following year it lets for cutting at 30 *l.* per acre, and the next year at 20 *l.* per acre; next year it is broken up for potatoes, and the crop is wonderful. And meadow land, watered by the sewage, is let at the astonishing rate of 38 *l.* per acre. The apprehension of danger to health or disagreeable stench arising from the application of sewage in a liquid form is most groundless."

Of the manurial qualities of the sewage for Italian rye grass the Earl of Essex speaks as follows:—"I put on my Italian rye grass about 60,000 gallons, *i.e.*, 270 tons per acre after each cutting. I am now entering on my fifth cutting. No other manure has been applied except 1½ cwt. of guano, washed in after four enormous cuttings, each about 10 or 11 tons per acre, from sewage only."

James Caird, Esq., M.P., "Times" Commissioner, in his "English Agriculture," page 285, states:—"On the farm of Mr. Stansfeld, M.P., one field is manured by sewage from a populous neighbourhood. The produce (Italian rye grass) of this field is always cut and carried into the stables for consumption. Each year it is cut six times, and after each cutting it is dressed with liquid manure."

Fattening Properties of Sewage Rye Grass.

With reference to the fattening properties of sewage manured grasses, Mr. Way's recent analysis has revealed the astounding truth "that grasses irrigated with sewage contain 100 per cent. more meat making matter than grasses not irrigated." On this subject the Earl of Essex states:—"Doubts have been raised as to the fattening properties of sewaged Italian rye grass. I have had 13 bullocks, 2¼ years old, feeding entirely and solely on cut rye grass in the yard all the summer, never having had an ounce of cake or corn since they were born, and have sold some of them for nearly 20 *l.* a piece. Better or fatter beasts, full of inside fat, could not be wished for, which is proved by the eagerness of the butchers to have six which I have left."

The Manurial Value of Sewage for Turnips and Wurzel.

The Earl of Essex's experience with the sewage for mangold wurzel is as follows:—"In 1857 I had nearly seven acres of wurzel almost entirely taken by the fly, and during intensely hot and dry weather I transplanted five acres with the assistance of the sewage, and, although a transplanted crop, it was the largest I ever had, over 43 tons per acre."

"I have myself made experiments on turnip seed with town sewage, with the most satisfactory results. As soon as the seed was sown, the land was irrigated with sewage, the seed immediately germinated into strong, healthy plants, and were out of danger from the turnip fly before the seed not

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not irrigated made its appearance above the ground."—Mr. G. Shepherd, C.E., on London Sewage.

The Manurial value of the Sewage for Wheat.

On the manurial value of town sewage for the production of wheat, Baron Liebig, in a letter dated 8th January 1860, states as follows:—"The contents of the reservoirs of the Fortress of Rastadt, in the Grand Duchy of Baden, which received the deposits of a garrison of 8,000 men, were sold in 1858 for 8,155 florins, 815 *l.* 10 *s.* English money. The commune of Oligheim, near Rastadt, consumed the greater proportion of this sewage, and in course of a few years they converted the most sandy, unproductive soil into flourishing corn fields."

The Earl of Essex states:—"Last year, having heard it stated that sewage was not good for wheat, I marked out two adjoining acres in the centre of a field. No. 1 received 60,000 gallons, =270 tons; No. 2 received nothing.

				£.	s.	d.
No. 1 produced 53 bushels, worth, at 6 *s.*				15	18	–
And straw, 5 loads at 30 *s.* - -				7	10	–
	£.	s.	d.	23	8	–
No. 2, 44 at 6 *s.* - -	13	4	–			
Straw, 4 ¾ loads - -	7	2	6			
				20	6	6
Value of produce per acre in favour of sewage with one dressing - £.				3	1	6

Farming Profits.

Influence of sewage manure on my own farm profits, by J. J. Mechi, Esq.:—I am much indebted to the sewage system on my farm in this respect. For the last six years my gain as landlord and tenant on my little farm of 170 acres has been nearly 700 *l.* per annum. Even the last year, with wheat at 42 *s.* per quarter, I have gained 600 *l.*, after paying every expense. Of course, much of this benefit has arisen from steam power and deep cultivation, and other improvements, but the liquified manure system has greatly contributed to this result.

"Show a manufacturer how to save 6 or 7 per cent. in the production of his goods, you give him a tremendous advantage over his rivals in the market. But to the landed interests we offer no such small considerations. If the sewage is applied to fertilise our fields, it will increase the produce of the soil from 200 to 300 per cent. per annum, and enable our farmers to supply grain and cattle for our markets at a rate no foreigner can compete with."—Mr. Shepherd on the Sewage of London for Agricultural Purposes.

National Waste.

"In the year 1855–56, above 10,000,000 cwts. of guano were imported, of which the greater portion remained in England. In the course of half a century, above 60,000,000 cwts. of bones have been imported into that country, yet all this mass of manure is not worth mentioning when considered in relation to the arable surface of Great Britain, and is but as a drop when compared to the sea of human excrement carried by the rivers to the ocean."—Baron Liebig ("Modern Agriculture," p. 222.

Sanitary part of the Question.

Those using the sewage speak as follows:—

Mr. Lawrence, Court Farm, Malvern, says:—"I have never heard any one complain of the sewage. It is not a mile from the farm into the town; you see, my house is within a couple of stones throw from us. I do not smell anything; but I shall be glad when we get it into the next field, which is before my door; we shall have the sewage on there in the spring. No, there is very little or no smell; the soil soon deodorizes it."

Mr. Morrison, Farmer, at Malvern, being asked if there was any complaint about the smell, replied:—"No; I am anxious to get the sewage across the valley into the field before my house door; it would improve that field very much. No; there is no more smell than there is now, and you see the field is now under the process of irrigation with the sewage as it comes out of the sewer. I have no complaints from any one."

The Earl of Essex states:—"As to the sanitary part of the question, I can only say that neither of my men who live at the work, the engine, and tanks, or the two men who handle the hoses and who smell the sewage more or less all day, have ever once complained of any bad effects whatever."

Copies of the engineer' reports and other information may be had at the Company's offices.

The Manurial Value of Sewage for Grass Land in Cold Seasons.

THE following extracts from correspondence with farmers using the sewage manure will show the state of their pastures during the late cold winter, which has proved so disastrous to farming stock in almost every part of the kingdem, and will no doubt be read with interest by our agriculturists, as, by their experience, the use of sewage manure would in a great measure prevent the recurrence of such disasters, and avert the calamitous effects of the present almost famine price of agricultural produce:—

EXTRACT from the letter of Mr. *N. Morrison*, Bedford House, Malvern.

Dear Sir, 2 May 1860.

IN answer to your letter of the 26th ultimo, I have to inform you I have left the Links Farm. . . . . I was then paying for the 90 acres of land, 160 *l.* At the time I took it I could scarcely raise a new seed for an old one. I left the farm in consequence of my landlord giving me notice to quit, with the view of raising my rent. Upon my own improvements the farm now lets for 373 *l.* per annum.* Only 20 acres out of 90 are irrigated. My opinion, after six years' experience, is that irrigation with sewage is the finest thing possible for grass land; the quantity of stock it enables you to keep is surprising. The bite is much earlier, and continues much later than on the non-sewage lands.

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* An increase in the rental from 35 *s.* 6 *d.* to 4 *l.* 2 *s.* 10 *d.* per acre.

"The present tenant is Mr. Adams; he may be able to give you the information you require."

EXTRACT from Mr. *Adams's* Letter, the present occupier of the Links Farm, Malvern.

"Dear Sir, 7 May 1860.

"In reply to yours of the 3d instant, I am well off for grass upon the lands upon which the sewage has been running; indeed, my grass looks very green, and, should the weather take up, and we get some warm, genial rain towards the end of this month (May), I shall commence hay-making; in fact, I am now mowing grass for 13 cows, besides horses, and have been for nearly a fortnight. Since I took this place I have carried the sewage over 10 acres more land than was before irrigated, and feel confident the cattle generally do better from either the grass in a green state or in hay, than from any grown under different circumstances. I sm sure if farmers generally considered their own interests, they would not allow one particle of water, even from their farm yards, to run to waste. I am running the sewage now over the grass after cutting, and you will be astonished to see the rapid growth it makes.

"I am, &c.
(signed) "*J. V. Adams*.

"G. Shepherd, Esq., C.E."

EXTRACT from the Letter of *G. M. Cann*, Esq., Court Farm, Malvern.

"Dear Sir, 5 May 1860.

"I AM glad to say that my two meadows manured with town sewage are full of keep, although I now have, and for the last three weeks have had, 200 sheep, and more than 30 head of cattle in them. The grass is fast growing upon them. I have no hesitation in saying that, where town sewage can be carried over land there is no manure equal to it. I find that where it has been turned off only a few hours, cows, horses, and sheep will graze most eagerly. I have this winter kept 50 horses, and more than 300 sheep, yet I am thankful to say that I have now by me, owing to the sewage, between 60 and 70 tons of hay of first-rate quality, which I am selling in this place at six guineas per ton. My meadows are, as you may remember, very uneven on the surface, and therefore I keep a man constantly employed in attending to the irrigation, and say that, for six or eight months, at a cost of about 8 *s.* per acre,—a small sum for an extra ton of hay, and full 50 per cent. more grass per acre. My neighbour, Mr. Adams, Links Farm [*see* Mr. Adams's letter] has mown grass for his milking cows for nearly a fortnight, and is regularly doing so. He is as fully convinced as yourself of the efficacy of the sewage wherever it can be got, and is more sanguine than myself, if possible, as to the result of its effects. * * *

"I am, &c.
(signed) "*George M. Cann.*

"G. Shepherd, Esq."

It has been stated that the sewage is only applicable to light lands. Both farms at Malvern are heavy clay soil, and but very indifferently drained, yet the pastures for the cattle have been most abundant under the most trying circumstances.

EXTRACT from the Letter of the Right Hon. the Earl of Essex, in reference to the Watford sewage.

"Sir, Cashiobury Park, 2 May 1860.

"IN reply to yours of the 26th ultimo, I beg to say that about the 1st April, I began feeding off three acres of Italian rye grass, which was sowed on wheat last summer, and were watered with sewage in the autumn and early part of this year. When that was fed off my ewes and lambs went to ten acres sowed with barley last year, and also well watered. The two fields gave my ewes and lambs nearly a month of good feed, and I really know not what I should have done without it. The first piece is now ready to feed off again. I have seven acres of rye grass of last year, which is looking wonderfully well, and I shall begin cutting it for bullocks in my yard in a week, or less. Had the weather not been so cold I should certainly have been able to cut it a week or ten days ago.

"Yours, &c.
(signed "*Essex.*

"G. Shepherd, Esq."

From the "Times," 23d December 1859.

"THE philosopher who asserted that dirt was only a good thing in the wrong place, could have had no conception of the magnitude of the truth to which he gave so sententious an expression. The maxim has now acquired a scope perfectly incredible. The mere displacement of a particular substance is said to threaten us at this very moment with some of the most terrible calamities that can befall a State. Our sewage is in the wrong place, and, because it is there, and not in the right place, we are incurring enormous risks. Sanitary authorities assure us that unless we remove this matter from our towns and dwelling-places life will be abridged, and society ultimately disorganized. Agricultural authorities impress upon us with equal earnestness that unless we forthwith transfer this very matter to our fields the soil will cease to be productive, and the population decay for lack of food. Town and country are thus menaced with ruin from one and the same cause, while each would be relieved by one and the same remedy. What is worse than worthless in one place would be invaluable in the other. We hardly know where to find an illustration of this extraordinary phenomenon. Perhaps the image of a father of a family, choked by a nugget of gold in his throat, while his children were perishing for want of the bread which that gold would buy, may convey some notion of the state of things depicted for our warning.

"One half of the case, it will be remembered, we have fairly accepted. Tardily, but in the end, with a resolute conviction, we have determined to remove all sewage matter from our towns, and especially from this immense metropolis. That branch of the proposition, then, we may dismiss for the present. Mr. Thwaites and his colleagues have got the money and means to drain London of its refuse most effectually. We shall take this refuse from its wrong place, and it remains only to be considered whether we shall put it in its right place. Now, if anybody is doubtful as to where this place may be, we can only recommend a perusal of Baron Liebig's opinion on the subject. That opinion we publish this morning, and few people after reading it will think that we have over-stated its purport. Whether its doctrines can be absolutely sustained is another matter; but

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but there are the views of that eminent authority distinctly expressed. His theory has certainly a foundation in truth. He asserts that the elements of fertility contained in the natural soil of the earth are not inexhaustible, and that, if they are constantly, abstracted and never replaced, the supply must some day fail. The earth is productive by virtue of these elements, a portion of which passes away with every crop raised from it; but as they do not reproduce themselves spontaneously they must either be restored to the ground artificially, or, in the end, they must cease to exist, and then farewell to the fruits of the earth.

"Already we have had symtoms premonitory of this consummation. Our fields began to fail, and we are strengthening them with guano and bone-dust. But bone-dust and guano are only ephemeral aids. They are almost exhausted already. No more bones are to be procured from Germany, and, indeed, as our readers have seen, people, go even to Sebastopol for a cargo. Guano cannot last above 25 years at the outside, and then what is to be done? One thing only, says Baron Liebig, and 'that ought to have been done years ago. We must restore to our fields what we incessantly abstract from them in the shape of corn and cattle. We must return our sewage to its right place, and then it will once more be well with us, and England may remain fruitful for generations to come.'

"In point of fact, our situation is such that we must needs accept it with alacrity. We have taken one of the two steps which constitute the whole proceeding, and it would be preposterous to stop half way. Sewage matters are to be removed from our towns. The substance will be taken from its wrong place, and we shall have got it accumulated in reservoirs or at outfalls, waiting for disposal. What is more we cannot tell how to dispose of it, or where to bestow it. We have thrown it into the Thames, and ruined our metropolitan stream. We wanted to throw it in a little lower down, but that would not do. We can hardly carry it to the sea, for it would cost too much money. It is, or will be, out of its wrong place; but where is the right place to be found? Baron Liebig and Alderman Mechi here come to our relief. Turn it into your fields, they say, and you will be the great benefactors of the age. The vitality of the State depends upon it. You cannot do without it. You are at present protracting a dependent and most precarious existence by means of South American manures and North American bread stuffs. The New World is bolstering up the Old World for a time; but this cannot go on. Now the very substance, which is pollution to you in one place, will be salvation to you in another. The sewage of towns well bestowed will relieve you from all anxiety, and preserve the fertility of your soil and the strength of your population from impoverishment or decay.

"We can only say that the theory is far too agreeable to be scouted. We should like nothing better than to see town and country come fairly to terms on the question. If our Drainage Commissioners could but discover that, instead of a substance worse than useless, they were disposing of a substance readily marketable, London might be relieved of its sewage-rates as well as its sewage. At present it is all outlay and no return, the only profit being in the good riddance of the refuse; but if these 'avails,' as Baron Liebig calls them, could be brought into demand, the whole process would be self-supporting, and the main-drainage might be paid for by the value of its own produce. Cannot this be managed? Must we still let all run to waste, when wealth as well as health might be realised by the same machinery? Our sanitary authorities talk to us, and we have listened to them with great advantage. Now, Baron Liebig and Alderman Mechi are addressing us just as forcibly, and demanding attention in their turn. We think they ought to receive it."

Extracts and Correspondence.

"In addition to the sewage of London, the wash from our streets during the first half-hour of a smart shower of rain, is most valuable: it contains the droppings from the thousands of horses and cattle which daily traverse the streets, the carbonaceous deposits from the tops of the houses, the washings of our market places, fish-stalls, &c., &c., a manurial treasure, organic and inorganic. 'All this goes into the Thames.'"—Mr. George Shepherd on the London Sewage for Agricultural Purposes.

"The streets of our towns are the horses' water closets."—Mr. Chadwick.

"As a general rule (except on particular soils), our parks are poor, mossy, and unsatisfying to deer and other animals. Sewage would alter all this: bringing sweet and abundant herbage, promoting and prolonging the growth of our noble timber trees. If you doubt it, examine Lord Essex's park at Watford, where the mere application of sewage has destroyed the drab and coarse ferns, and substituted for them rich green, soft herbage. The line of demarcation where the sewage has not reached, is strikingly illustrative of its great merits. There are many extensive filtrative wastes and commons lying within reach of our large towns and cities, which would, by the mere application of sewage, become covered with a rich and spontaneous vegetation acceptable and fattening to animals. Non-filtrative wastes would require drainage."—Mr. Mechi, on the Sewage of our Towns.

"Show a manufacturer how to save 6 or 7 per cent in the production of his goods, you give him a tremendous advantage over his rivals in the market. But to the landed interests we offer no such small considerations. If the sewage is applied to fertilise our fields, it will increase the produce of the soil from 200 to 300 per cent. per annum, and enable our farmers to supply grain and cattle for our markets at a rate no foreigner can compete with."—Mr. Shepherd on the Sewage of London for Agricultural Purposes.

"In the year 1855-56, above 10,000,000 cwts. of guano were imported, of which the greater portion remained in England. In the course of half a century, above 60,000,000 cwts. of bones have been imported into that country; yet all this mass of manure is not worth mentioning when considered in relation to the arable surface of Great Britain, and is but as a drop when compared to the sea of human excrement carried by the rivers to the ocean."—Baron Liebig ("Modern Agriculture," p. 222.)

"Our fields are like a well of water. For centuries those elements which are indispensable to the reproduction of the crops have been taken from the soil in those crops, and that too without being restored. It has only recently been ascertained how small a supply of these elements the soil really has. A beginning has been made to restore to the fields the losses which they sustained through the annual harvests, by introducing from the external sources manures containing the same elements. Only a very few of the better informed farmers perceive the necessity of this restoration, and those of them who have the means have zealously endeavoured to increase the amount of these elements in their fields; but by far the greater part of them know nothing of such restoration. They think that they may continue to take from the field as long as there is anything left, and that it will be time enough to provide for this necessity when it knocks at their doors; they do not, of course, know how large their stock on hand is, nor are they aware that when the necessity shows itself there will be no means to correct it; they know not that what they have wasted is irretrievable. The loss of these elements is brought about by the 'sewerage system of towns.' Of all the elements of the field, which in their products, in the shape of corn and meat, are carried into the cities and there consumed, nothing, or as good as nothing, returns to the fields. It is clear that if these elements were collected without loss, and every year restored to the fields, these would then retain the power to furnish every year to the cities the same quantity of corn and meat; and it is equally clear that if the fields do not receive back these elements agriculture must gradually cease. In regard to the utility of the avails of the 'sewerage of towns' as manures, no farmer, and scarcely an intelligent man, has any doubt, but as to their necessity opinions are very various. Every farmer who takes a sack of corn, or a cwt. of rape, turnips, potatoes, &c., to the town ought, like the Chinese coolie, to carry back with him from the town an equal (or, if possible, a larger) quantity of the mineral constituents of the produce sold, and restore them to the field from which they have been taken. He should not despise the peel of a potato nor a straw, but always bear in mind that that peel may be wanting to form one of his potatoes; that straw to form one of his ears of corn."—Baron Liebig (in a letter to the "Times," 23d December 1859).

"If the sewerage be judiciously applied to the land, I am fully persuaded that not only would the health of the town population be greatly improved, but the finances of the agricultural population would derive considerable benefit from the change."—Lord Palmerston.

The following letter has been received from Baron Von Liebig:—

Dear Sir, Munich, 2 January 1860.

I HAVE read your pamphlet with great pleasure. It has given me the conviction that your plan for the recovering of the manure element out of the sewers of London is perfectly practicable, and that the difficulties I supposed stood in its way, are much easier to surmount than I thought. It is a most fortunate event that men like Mr. Mechi and yourself are determined to devote their energies to that true cause of humanity; I am sure you will succeed.

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I shall be happy to join in your efforts, and shall think myself honoured to call myself consulting chemist to your undertaking.

Believe me, &c.
(signed) *Justus Von Liebig,*
President of the Royal Academy of Science, and Conservator General of the Royal Collections, and Professor of Chemistry.

George Shepherd, Esq., C.E.

29, Austinfriars,
Dear Baron Liebig, 6 January 1860.

YOUR "Chemistry of Agriculture," page 165, contains the following paragraph:—"The domestic arrangements peculiar to the English render it difficult (perhaps impossible) to collect the immense quantity of phosphates which are daily sent into the rivers in the forms of urine and excrements."

This statement, coming from so eminent an authority, has induced most people to consider it almost impossible to do anything with the London sewage otherwise than throw it into the Thames. As my plan for utilising the sewage of London has received the approbation of all parties who have paid the least attention to this subject, will you be so kind as to favour me with your opinion.

I am, &c.
(signed) *George Shepherd,* C.E.

Dear Sir, Munich, 9 January 1860.

MY ideas about the possibility of collecting the sewage of London have undergone considerable change by the perusal of your pamphlet on "London Sewage, and its Application to Agriculture." The simple way in which you solve the problem has convinced me not only of the possibility but of the practicability of collecting the sewage of London for agricultural purposes.

If, in Cornwall (as you show by statistics), 22 steam-engines, total 1,140 horse-power, with a consumption of 1,413 tons of coal, have raised 11,000,000 tons of water, 20 yards high, in one month, it is easy to perceive the correctness of your calculations. Supposing the London Sewage to be 70,000,000 of tons annually, required to be raised 350 feet high, it could be done by steam-engine power representing 3,200 horses, or about the steam-power of four of your large steam-ships. This settles the whole question.

I am, &c.
(signed) *Justus Von Liebig.*

G. Shepherd, Esq. C.E.
29, Austinfriars, London, E.C.

Metropolitan Board of Works,
Sir, 31 October 1860.

I BEG to acknowledge the receipt of your communication of the 30th instant, and to inform you that the same shall be laid before the Metropolitan Board of Works.

I am, &c.
(signed) *John Pollard,*
Clerk of the Board.

G. Shepherd, Esq , C.E.,
26, Throgmorton-street, E.C.

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London Sewage.

Metropolitan Board of Works,
Sir, 1 August 1861.

I am instructed to inform you, that a meeting of the Main Drainage Committee of the Metropolitan Board of Works will be held at this office on Tuesday next, the 6th instant, at 2 o'clock, p.m., when your proposition for a concession of the sewage of London will be considered, and I am to request the favour of your attendance on that occasion.

I am, &c.
(signed) *John Pollard*,
Clerk of the Board.

G. Shepherd, Esq., c.e.,
24, Austinfriars, E.C.

London Sewage.

Metropolitan Board of Works,
Sir, 25 October 1861.

I am instructed to inform you that a meeting of the Main Drainage Committee of the Metropolitan Board of Works will be held at this office on Tuesday next, the 29th instant, at 12 o'clock at noon, when your proposition for a concession of the Sewage of London will be considered, and I am to request the favour of your attendance on that occasion.

I am, &c.
(signed) *John Pollard*,
Clerk of the Board.

G. Shepherd, Esq., c.e.,
24, Austinfriars, E.C.

Metropolitan Board of Works,
Spring Gardens,
Dear Sir, 16 November 1861.

I am directed to inform you that your communication, in reference to the sewage of the metropolis, together with others of a similar nature, having been under the consideration of the Committee to whom the subject has been referred, they have arrived at the conclusion that, before coming to a final decision with respect to any of them, it would be necessary that they should have every possible opportunity for testing the efficiency of the scheme in an engineering and chemical point of view, and for satisfying themselves that the requirements of the Act of Parliament relating to the subject shall in no way be infringed, by the creation of a nuisance in carrying out the works.

With this view, I am to request that you will be good enough to supply a map and sections, showing the area of the intended operations, the levels of its surface, and the lines, levels, and sizes of the intended acqueducts, indicating the various kinds of surface soil with which it is proposed to deal, and showing in detail what mode of subsoil drainage it is intended to adopt, if any, with the size, depth, and inclination of the several proposed lines of drainage, together with descriptions and particulars of the pumping power to be employed, the number of lifts, and the nature of the outfall.

Also, a statement showing the manner in which it is proposed to work the scheme, what kind of powers will be taken for dealing with the land to be operated upon, and how owners and occupiers are to be treated with; what quantity of sewage will be taken up daily, over what quantity of land it will be distributed, what depth it will occupy over that area of land, and, if it be intended to employ varying quantities at different seasons, what that variation will be.

Also, a full statement of the means of deodorization, if any, the chemical agents employed, and the details of their mode of application; and what arrangements, if any, it is proposed to make for dealing with the heavy deposit.

Also, an estimate showing, separately, the cost of the engines and pumps, if any, the conducting pipe or sewer, the distributory and deodorizing apparatus, and the subsoil drainage, together with the annual working expenses of each of these three heads of expenditure.

I am, &c.
(signed) *John Pollard*,
Clerk of the Board.

G. Shepherd, Esq., c.e.,
24, Austinfriars, City.

26, Throgmorton-street, E.C.,
Dear Sir, 30 November 1861.

I beg to acknowledge the receipt of your esteemed favour of the 16th inst., requesting me to furnish your Honourable Board with the following information in reference to the proposed concession of the sewage of London:—

1st. To furnish the Board with a map and sections, showing the area over which it is intended to apply the sewage, together with the various levels, and the size of our intended sewage mains.

2d. The description of the pumping engines, and the various outfalls for the sewage.

3d. The mode of dealing with the proprietors of the land, and the quantity of sewage to be used on each acre of land, and the method of subsoil drainage.

4th. How the sewage is to be used during the various seasons of the year.

5th. The method of deodorizing the sewage.

6th. The cost of the works per acre, and the general working expenses.

With reference to the first question, I would most respectfully submit the Honourable the Board of Works can form but little conception of the details they require me to furnish, or the expense, both in money and time, it will take to obtain it. The sewage of London will manure an area of 60 miles round London, consequently to get the level of every elevation required for our reservoirs, would cost us at least from 10,000 *l.* to 12,000 *l.*; therefore, I cannot ask my friends to go to any expense until we have got the concession in our hands.

What we ask of your Honourable Board is, that they should give us a concession of the sewage of London; bear in mind, we only ask for what you are going to throw away. We will then make an experiment on a suitable scale with the sewage of Coventry, over an area of not less than from 10,000 to 12,000 acres of land; as soon as this is in operation we commence the general survey for the application of the London sewage, and as soon as the plans and estimates are complete, we will furnish your Honourable Board with copies of the same, and also apply to Parliament for the necessary powers to carry out the works. We require no

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no aqueducts of any kind in the shape of open canals. In my plan for applying the sewage, we follow the natural surface of the ground in every district, and the sewage flows to every field by gravitation.

2d. I propose to use the Cornish engines, with "Plunger Pumps," for the purpose of raising the sewage to the required elevation for distribution over the land. We take the sewage as it flows from the outlets of the new sewers, while each field will become our outlet, and the fertilizing elements absorbed by the soil.

3d. We propose to supply the sewage manure to the farmers in quantity *ad libitum*, at the rate of 30 *s.* per acre per annum.

But no sensible farmer would apply more than 200 tons to the acre of this manure at each dressing for his land. While experience has proved that the sewage for manure is applicable to every class of soil, we do not in any way intend to interfere with the subsoil drainage, and where the sewage is properly applied, no extra drainage is required.

4th. With reference to the consumption of the sewage, it will be required all the year round. First, for the wheat lands and autumn dressings; in the winter and spring for the grass, barley, oats, turnip land; then to irrigate the fields after the first crops of grass and clover are cut; in a word, when once in operation, not a drop of it will be wasted, and I have no doubt the demand will exceed the supply.

5th. We do not in any way deodorize the sewage; such a process would not only be very expensive, but it would utterly ruin the fertilising powers of the sewage; the only deodorizer requisite, is the water it contains, while, when it is applied to the soil, the process of deodorization is in a few moments most complete.

6th. The cost of applying the sewage, in the first instance, over a given area, will not exceed 3 *l.* per acre; this includes the cost of pumping engines, reservoirs, sewage, mains, &c. &c. With regard to the working expenses, from our experience at various Cornish mines, the cost of pumping will not exceed one farthing for five tons of sewage raised in the shape of fuel. After deducting the cost of pumping and general expenses, it will be seen that 30 *s.* per acre for 200 tons of sewage will leave an ample per-centage on the capital for constructing the works. The cost of the pumping will be the chief item in the working expenses, nearly all the rest will be self-acting.

As far as I can ascertain, the quantity of sewage generated in London is unknown. An eminent Cornish pumping engine manufacturer and myself estimated it will require 2,000 horse-power on the Middlesex, and about 800 horse-power on the Surrey side, to raise the sewage to the elevation required for the purposes intended.

I shall be most happy to furnish the Board with any further information in my power. But I fear it will be impossible for us to furnish a complete plan of the intended works, while a partial survey would be only time and money thrown away. With regard to the proposed experiments with the sewage, this experiment will be made at Coventry instead of at Croydon; for a distance of two or three miles from the latter town each landed proprietor is anxious to let the land on building leases, consequently they do not care to have the sewage applied to their land. But no such objections are raised in the neighbourhood of Coventry, while the landowners are ready to give us every possible assistance. In conclusion I would add, I have given this subject the most careful consideration for many years, and I feel confident when we have got the first works in operation, instead of the sewage of our towns being regarded as a nuisance, it will be anxiously sought after by our landed interests.

As the whole of the sewage will be applied out of the jurisdiction of the London Board of Works, it cannot possibly interfere with any existing Acts of Parliament.

I am, &c.
(signed) *Geo. Shepherd*, C.E.

J. Pollard, Esq.,
Clerk to the Honourable the
Board of Works.

London, 26, Throgmorton-street, E.C.,
Dear Sir, 3 December 1861.

I FIND I have one or two opponents asking for the concession of the sewage, the one a person named Ellis. I beg to inform you this man is an Irish solicitor, struck off the Rolls for "a cause;" he has formed an acquaintance with a clerk discharged from my office, and from other places, for his not very honest conduct, but neither of them have not the slightest knowledge of the subject on which they are troubling you about; in fact, they are unworthy of a moment's consideration. With reference to Mr. Kirkman, this gentleman has written me letter after letter on some process he has patented for extracting the solid matter from the sewage. His process, to say the least, is simply absurd.

I should feel obliged if your Board would settle the question of the concession, as I am very anxious to get everything arranged for commencing the works at Coventry in the course of the ensuing spring.

I am, &c.
(signed) *Geo. Shepherd*, C.E.

J. Pollard, Esq.,
Clerk to the Honourable the
Board of Works.

26, Throgmorton-street, E.C.,
Sir, 11 January 1862.

I BEG to inform you, for the information of your Honourable Board, that I shall be prepared to submit to you an outline of my plan for the application of the whole of the sewage of London in a few days, with full description.

I am, &c.
(signed) *Geo. Shepherd*, C.E.

J. Pollard, Esq.

26, Throgmorton-street, E.C.,
Dear Sir, 13 January 1862.

PERHAPS no person in England has devoted so much time and attention to the question of the sewage of our towns for "Agricultural Purposes" as myself. This being the case, for the information of your Honourable Board, I beg to offer a few remarks on the proposition of Messrs. Napier and Hope for the sewage of the north side of London, for the purpose of applying it to an area of 2,000 acres of land. The quantity of sewage appears

App. No. 14. appears to be about 10,000,000 cubic feet per day from the north side, or about 3,650,000,000 cubic feet per annum. While the 20,000 acres of land contain only 96,800,000 square yards of surface, which would give about 38 cubic feet of sewage for each square yard of land, or about 5,000 tons of sewage to the acre per annum. Now, experience has shown that 250 tons of sewage to the acre is as much as the land requires, and as much as can be safely applied at each dressing; consequently, these gentlemen would find they had 4,750 tons of sewage for each acre more than they required, while to run it over the land to one-fourth the extent they propose, it would create a dire pestilence in the immediate locality of their works.

Again, grass or meadow land alone would take, say, three dressings with the sewage per annum, giving a crop of grass after each dressing.

But after each dressing of arable land, two, if not three crops, must be taken, or the land would become so rich, that it would throw up nothing but rank grasses instead of grain.

From these facts, I think your Honourable Board will readily perceive that when I state the sewage of London will irrigate or manure an area of 50 or 60 miles round London, I am much nearer the mark than with 20,000 acres of land. I have already explained the difficulties which stand in the way of supplying you with a detailed plan of the proposed works. But if your Honourable Board will be so kind as to appoint an early day, I shall be most happy to attend and submit my outline plans for their inspection, and to explain the mode of applying the sewage generally.

My proposed system has already received the approbation of the late R. Stephenson, Esq., C.E., Baron Liebig, the Earl of Ellesmere, Lord Calthorpe, the Earl of Denbigh, J. H. Langston, Esq., M.P., and numerous other large landed proprietors; and I have no doubt it will be fully approved by your Honourable Board. But I feel it is useless to attempt to apply the sewage of London on a large scale until it has been fully tested on a suitable size area of land first, and this is the general impression of large landed proprietors and others; consequently, if your Honourable Board will grant me a concession of the whole of the London sewage on the terms I have already proposed, it is intended to commence the works for the sewage of Coventry over an area of not less than from 8,000 to 10,000 acres of land; six months after the completion of the works will fully test the efficiency of the system.

The Coventry works being complete, I then propose to commence with the sewage of the south side of the Thames, and, as soon as possible afterwards, with the works for the distribution of the northern sewage. Once these works are in operation, we shall hear no more of animal food being 9*d.* per pound for our families, and for the families of our poor working classes, or of scarcity of any other class of agricultural produce our own soil can produce, and our climate bring to maturity.

Waiting your reply,

I am, &c.
(signed) *Geo. Shepherd*, C.E.

J. Pollard, Esq.,
Clerk to the Honourable the
Board of Works.

Metropolitan Board of Works,
Sir, 17 February 1862.

At the meeting of the Metropolitan Board of Works held on Friday last, the subject of the several propositions for taking the sewage of London was brought under the notice of the members, and I laid before them the several papers relating to your scheme; but the attention of the Board having been called to the fact of the intention of Government to acquiesce in the appointment of a Committee of the House of Commons to inquire into the best means of utilizing the sewage of the cities and towns of England, with a view to the reduction of local taxation and the benefit of agriculture, they adjourned the further consideration of the matter until that Committee shall have made their report.

I am, &c.
(signed) *John Pollard*,
Clerk of the Board.

Geo. Shepherd, Esq., C.E.,
26, Throgmorton-street, E.C.

5, Barge Yard, Mansion House,
Sir, 21 August 1862.

I HAVE the honour to address you again in reference to "The Concession of the Sewage of London." The report of the Select Committee on the town sewage in every way confirms my statements in reference to the manner the sewage should be applied to the soil. This being the case, I beg again to solicit your Honourable Board to grant me a concession of the sewage of London, "And in the first instance for the sewage on the south side of the River Thames," on the terms proposed in my previous letters. On the concession being granted, an experiment on a large scale will be made with the sewage of the town of Coventry, under the Presidency of the Right Honourable the Earl of Shrewsbury and Talbot, and other noblemen and gentlemen. The sewage of Coventry will be applied over a large area of land, and on the principal now confirmed by "The Select Committee on Town Sewage."

During the time the works at Coventry are being carried out, the requisite surveys will be made out for the London works, and the sanction of Parliament obtained for the same.

I shall be most happy to submit to your Honourable Board the outline of the proposed works for the south side of London.

Waiting your reply,

I have, &c.
(signed) *Geo. Shepherd*, C.E.

To the Secretary, the Honourable the
Board of Works.

26, Throgmorton-street, E.C.,
Dear Sir, 9 June 1863.

IN reply to the advertisement in reference to the concession of the sewage of London, I most respectfully beg to state that I adhere to the proposals made in my former letters in reference to the sewage of London. I also beg to inform you that in a very short time I shall be ready to lay before your Honourable Board the plans for applying the whole of the sewage of London to the soil; and in 1864, to bring a Bill into Parliament for the necessary powers to enable the promoters to carry out the necessary works, if the concession is granted by your Honourable Board on the conditions named in my previous letters.

In the first instance, I beg to ask for the "Concession of the Sewage" on the south side of the Thames. I am also prepared to submit the names of the gentlemen who will act with me in this matter; and pending the application to Parliament, an experiment with the sewage of Coventry will be made on a large scale. These works have been delayed in consequence of the Select Committee and other Committees appointed by Parliament and the Government on this subject.

Waiting your reply,

I am, &c.
(signed) *Geo. Shepherd*, C.E.

J. Pollard, Esq.,
Clerk of the Metropolitan
Board of Works.

P.S.—Being at this moment in the country, I am just informed that your Honourable Board have postponed this subject for two months longer. Please inform me if this is so.

G. S.

Metropolitan Board of Works,
Dear Sir, 16 June 1863.

I BEG to inform you that the Metropolitan Board of Works at their meeting on Friday last, had before them your communication of the 9th instant, in reply to their advertisement for tenders for the metropolitan sewage, stating that you would shortly be prepared to bring a Bill into Parliament, and to lay before the Board plans for applying the sewage of London to the soil; and to apprise you that they have referred the same to the Main Drainage Committee.

I am, &c.
(signed) *John Pollard*,
Clerk of the Board.

Geo. Shepherd, Esq. C.E.,
26, Throgmorton-street, E.C.

26, Throgmorton-street,
Sir, 11 July 1863.

I HAVE the honour to enclose the proposed terms for a concession of the whole of the sewage of London, to be granted to me in the first instance on behalf of a Company.

I apprehend that such a concession will be granted by your Board, subject to the sanction of Parliament, when the necessary powers are applied for, to enable the company to construct the works for the distribution of the sewage. I beg most respectfully to inform you, if the Board will grant me this provisional concession, a Bill will be brought into Parliament during the next Sessions, for the requisite powers to construct the necessary works for the utilisation of the sewage of the south side of the Thames; and pending the passing of the Bill, an experiment will be made with the sewage of one of the large towns in the Midland Counties, over 10,000 acres of land, for the inspection of your Board.

The cost of my plan for applying the sewage, does not exceed 3 *l.* per acre. I may add, several noblemen and eminent city merchants are interested with me in this undertaking.

Trusting your Board will grant me the concession, and thereby give every facility for solving this great "agricultural and sanitary problem," pregnant as it is with the best interest of all classes.

I have, &c.
(signed) *Geo. Shepherd*, C.E.

J. Pollard, Esq.,
Clerk to the Metropolitan
Board of Works.

P.S.—I shall be ready, at any time, to submit to the Board an outline plan of the intended works for the utilisation of the whole of the London sewage.

SUGGESTIONS for the Proposed Concession of the SEWAGE of *London.*

THE following suggestions are most respectfully submitted to the Metropolitan Board of Works, in reference to the proposed concession of the sewage of London, for the purpose of applying the same for agricultural purposes, viz.:—

First. That the Metropolitan Board of Works grant a concession of the whole of the sewage of London to me for a public company, on the following terms:

Second. That the company take the sewage from the new sewers, at such places as may be mutually agreed between the Board and the company.

Third. That, for the distribution of the sewage into the agricultural districts, the Company undertake to erect all the necessary machinery for pumping the sewage from the sewers, the construction of reservoirs, and all other works for the complete distribution of the sewage in the various localities for agricultural purposes.

Fourth. The Company to undertake the liabilities of all legal proceedings in reference to any and every nuisance they may cause in applying the sewage to the land, and also to pay for every damage the Company may do to property of every kind; and to relieve the Metropolitan Board from all legal proceedings and other expenses, so far as the Company's works for the distribution of the sewage is concerned.

Fifth. The concession to be granted, in the first instance, for a term of 50 years, as follows:—That from the revenue derived from the sale of the sewage in the agricultural districts, the company to be entitled to a preference dividend of 7½ per cent. per annum on the capital employed for constructing the necessary works and the working expenses in distributing the manure; and all proceeds beyond the 7½ per cent. per annum to be equally divided between the Metropolitan Board and the Company, such profits to be verified by the company's auditors, in conjunction with an auditor appointed by the Metropolitan Board of Works. Should the net profit in any year after the completion of the works not equal 7½ on the outlay, the company to be compensated from the profits of the following years, such compensation to be limited only to the first five years after the completion of the works.

Sixth. That at the expiration of the 50 years, the company to receive a preference dividend of 5 per cent. on their outlay; and all surplus profits to be divided between the Metropolitan Board and the company, as described in the preceding paragraph.

Seventh. That the company commence their works for the distribution of the sewage as soon as possible after the concession is granted, and the necessary powers obtained from Parliament for constructing the works.

Eight. That the Metropolitan Board of Works give every facility to the Company for erecting the necessary works for distributing the sewage, including the right of laying down sewage mains within the jurisdiction of the Metropolitan Board of Works.

Ninth. That all disputes which may arise between the Board and the Company to be referred to arbitration.

Tenth. That the Metropolitan Board have the power of nominating two directors on the Board of the Company, and also one of the auditors.

(signed) *Geo. Shepherd*, C.E.

26, Throgmorton-street,
11 July 1863.

P.S.—The works for the utilisation of sewage on the south side of the Thames to be put first into operation, and afterwards the north side.

TENDER for the METROPOLITAN SEWAGE, with an Explanatory Description of Works; a General Plan and Section of the Works for this purpose; a Plan of the Ground near the Outfall at Barking Creek appropriate for such Works; a Copy Specification of Patent; and Copies of previous Correspondence relative to the subject.

TENDER for the METROPOLITAN SEWAGE.

Seymour Chambers, 6, Duke-street,
Adelphi, 6 May 1863.

Gentlemen,

REFERRING to your advertisement for tenders to be received by you on the 7th for the 8th inst., for the disposal of the sewage by the Great Outfall Sewers of the Metropolitan Main Drainage, in tendering, I beg leave to premise that the system by which I am prepared to treat the London sewage will enable me to dispense with the great outlay contemplated by other parties who have proposed carrying it away in costly conduits, and utilising it at an expense variously estimated at from two to thirty-six millions, so that a moderate and easily attainable capital will suffice for my purpose, and distinguish my plan from others by its practical and strictly commercial characteristics.

I propose to take the sewage from the main outfall sewers of the Board before it enters the reservoirs now in course of construction, and pass it through the works I should provide, retaining for contingencies the reservoirs. For the purpose of those works, it would be necessary that the Board should provide and give me possession of sufficient land contiguous to the outfalls; calculating the rent as a small part of the royalty I agree to pay, and I submit this as an equitable condition in regard to the control over my works stipulated by the Board's advertisement, and also in regard to the importance of the royalty, which, according to my estimate, will average for the term hereafter mentioned over 50,000 *l.* per annum, while the sewage will be converted into a fertilizer in its best and most portable form, at a fair commercial profit, and so afford the desired solution of the vexed question of its utilization.

I herewith submit a description of works, with a general plan and sections, showing the details thereof, in which the mechanical treatment of the sewage is explained; and it will therefore, I doubt not, suffice to say here that the sewage is deodorized by any of the known agents for that purpose, as to which there is no secret, and which only require different manipulation at a subsequent stage not immediately concerning the subject of tender, or by such other agents, simple or compound, as, from time to time, may be approved by the Board. In this state the sewage is passed through the tanks, drying pans, and filters, shown in the accompanying plan, by which means the matter held in suspension and solution is perfectly separated from the aqueous portion, which may then be discharged into the Thames in a state "thoroughly divested of deleterious and offensive properties, pure and limpid," as I have already proposed by my letters to the Board of the 4th and 12th of July 1860, in reference to the Board's advertisement for tenders for the sewage at that date, to which I beg now to refer you (copies accompany this). The residuum is then treated by a separate chemical process, peculiar to myself, for utilization in a dry and solid state. It is free from noxious odour, and is equally uninjurious to health. It may be conveyed away to any distance in bags, barrels, or boxes, in carts or other vehicles, or in vessels by water, to farms or warehouses, where it can be held in stock without the least inconvenience, particularly from oppressive and detrimental odours or exhalations, in this respect favourably contrasting with guano, and most of the artificial manures in imitation of guano. When required for use, it can be applied at any season, on any soil, for any crop, with mixture, and in any form, whether roughly laid down for ploughing broadcast, with the drill, or in combination with water for liquid distribution.

The nominal amount of capital proposed for my Company is 250,000 *l.* in 50,000 shares of 5 *l.* each.

The duration of the contract to be 21 years from the completion of the works, which will be ready for operation within one year from the date of contract, and be finally completed, according to specification to be approved, within two years from the date of contract.

The royalty payable to the Board, to be settled on the basis of effective production; but taking into account the opposition against the introduction of sewage manure that has been raised, to be perseveringly urged by the manufacturers of artificial manure, and by dealers in guano, a series of years will be required to establish and stock agencies throughout the country; and their may ensue a long period of unprofitable business, during which it may reasonably be stipulated that no royalty should be paid. I propose that this probationary term be seven years. For the next succeeding term of seven years, I propose to pay to the Board a royalty of one-fifth of all profits beyond a 20 per cent. dividend on the capital of the company; and for the remaining term of seven years, I propose that the Board be paid one-fifth of all net profit above 5 per cent.; and for any further or other term, at such rate or royalty as shall be agreed upon and settled by the Secretary of State or Chief Commissioner of Works.

The stipulations as to the term and royalty, are subjects of fair discussion. I shall gladly make any modification therein, or on other points, as may on deliberation be reasonably suggested to meet the views of the Board, consistently with the financial security of the undertaking; and I shall freely offer to the Board any personal explanations which may be deemed requisite to place the question in all its bearings in the most explicit form for adjudication, or to adapt my proposal to the requirements of the case.

I now beg leave to recapitulate the terms involved in the foregoing explanation, with a view to specify the leading features of a contract on these bases.

The Board, on its part, would have to concede—

1st. The land for the construction of my works, as may be agreed.

2d. The delivery of the sewage from the main outfall sewers into those works.

3d. The access to the water frontage and user thereof, for the purpose of shipment, or for landing materials, with privilege to erect offices and sheds for stowage, &c.

4th. The grant of these for the term of seven years as probationary without rent or royalty, and the further term of 14 years, subject to rent or royalty as above stipulated.

I, on my part, agree—

1st. To take, deodorize, and utilise the sewage by separation, diverting only the aqueous portion in an inoffensive or innocuous state through channels to be provided by the Board for discharge into the river.

2d. To effect the manipulation and removal of the solid matter without nuisance.

3d. To pay to the Board the rent or royalty, with the contingent increase as above specified—that is to say, for the first period of seven years, after the said probationary term of seven years, one-fifth of all profits beyond 20 per cent. dividend on the capital of the company; and for the other or remaining term of seven years, one-fifth of all profits beyond 5 per cent. I am prepared to guarantee a minimum rent of 10,000*l.* per annum, to insure a practical result of this condition, although I estimate the actual returns to the Board as largely exceeding that amount.

4th. On the conditional acceptance of my proposal, or any modification of it that may be agreed upon, I undertake to furnish the names of two or more sureties for the performance of the conditions of the contract.

5th. In case the Board should hereafter desire to determine the concession before the expiration of the grant, I consent to a surrender of the same on two years' notice, subject to the repayment of the capital invested, with the addition of 25 per cent. premium, and to the payment to myself or my representatives of a royalty of only one per cent. for the use of my system while my patent lasts.

In conclusion, I beg leave to state that most of the schemes for the utilisation of sewage have failed from their having been based upon the combination of expensive materials with the liquid sewage and mechanical processes, which, from the bulk of the material operated upon, were of necessity very costly.

In the process which it is now proposed to bring into operation, neither of these sources of failure exist. The sewage is permitted, while flowing over shallow beds, to deposit its more solid constituents by the simple force of gravitation; and instead of expensive chemical constituents being required, with which to combine the more valuable qualities of the sewage, viz., those held in solution, these are allowed to combine of themselves with the earth (specially prepared it is true, but at a mere nominal cost), thus merely repeating with design the process which Nature has at all times been carrying on before our eyes.

I have, &c.
(signed) *C. F. Kirkman.*

To the Metropolitan Board of Works.

Supplementary Tender for the Metropolitan Sewage.

In formal compliance with the Board's advertisement under date 11th May 1863, giving notice of having extended the time for receiving tenders for the disposal of the sewage of the metropolis until Friday, the 10th of July instant; with the copy of a letter from Mr. G. K. Radford to the undersigned, in explanation of that gentleman's letter to the Board, dated 7th May 1863; also, samples of the solid and fluid elements of the sewage of Leicester, treated by my system; the former a highly valuable fertilising agent, the latter perfectly pure and pellucid, the sewage manure having been extracted from it.

(signed) *C. F. Kirkman.*

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No. 6, Duke-street, Adelphi, W.C.,
Dear Sir, 6 July 1863.

In pursuance of the former advertisement of the Board, I had, on the 7th of May last, the honour to deposit my tender, under date the 6th May, for the metropolitan sewage.

With a view to allow parties presumed to be represented by Mr. Radford the opportunity of preparing plans and sending in proposals after the date appointed by the Board, a further delay was ordered, and a new advertisement published, calling for tenders on the 10th of July instant.

As a formal compliance with the latter, I hereby beg leave to refer to my tender presented on the said 7th May last, and to state that I now renew and confirm the same.

It certainly was with great surprise that I learned at the Board's meeting of the 8th May, that the application for the extension of time had emanated from Mr. G. K. Radford, as I had myself been in communication with that gentleman, as agent for Mr. John Fowler, Civil Engineer, at the close of 1861 and beginning of 1862, with a view to the development of my plans for the utilisation of sewage; and I had not for many months prior to my tendering to your Board any communication from Mr. Radford on the subject; I was, however, still more surprised to find on inquiry that his application to the Board had been made on my behalf, though without my being informed of it by him; and I think it but due to myself to mention this fact, and to append a copy of Mr. Radford's subsequent letter to me, which is as follows:—

"44, Parliament-street,
"Dear Sir, "19 May 1863.

"Mr. Fowler has handed me your letter of the 14th inst. I wrote to the Board of Works at his request, to obtain an extension of the time for delivering tenders, and I see that they have granted an extension of two months. Having made the request, I consider myself bound to make a *bonâ fide* offer, and as the request was made for you, I must look to you to clear me in the matter. I shall be glad, therefore, to know what you propose doing about it, and am

"Yours, &c.
(signed) "*Geo. Kent Radford.*"
"C. F. Kirkman, Esq."

I beg to add a statement which may be taken by the Board, as I presume to hope, into their consideration, in regard to the merits of my proposal.

Since my tender was presented, and after a long and deliberate investigation, the Leicester Board of Health has granted to me the concession of their sewage. I herewith beg to submit a sample of the fluid and solid elements of that sewage, treated by my system, the former perfectly pure and pellucid, in which form the aqueous portion of the London sewage, if granted to me, would flow into the Thames, and the latter a highly valuable fertilizing agent, capable of application either in a fluid or solid state, and so contributing a proportionate development of agricultural resources, notwithstanding the dicta of scientific men, to whom one practical mode, at least, of treatment is unknown, and despite the interested opposition of others. I pledge myself to the efficiency of my system to that extent; and, if the Board desire proof on a larger scale, I can satisfy them to the extent of at least 3,000 tons, which are now available for the experiment at the Leicester Works.

I have, &c.
(signed) *C. F. Kirkman.*

To John Pollard, Esq.,
Clerk of the Metropolitan
Board of Works.

Argyll-street, Regent-street,
Gentlemen, 27 November 1858.

The attention of your Board has been, for some months past, and I believe still is, seriously devoted to ascertain the best mode for deodorization and deposit of sewage.

I have a simple inexpensive plan, which is the result of much inquiry and more than 20 years' experience, in treating sewage for private purposes; and I am anxious to test it for your satisfaction upon a large scale, and beg that you will be pleased to grant me permission so to do at the King's Scholars' Pond Sewer, Pimlico.

I have been in communication with the Sewage Manure Company, and they are willing to enter into arrangements with me, so far as they have power by their Act of Parliament, which I think extends only to the sewage itself; but, as certain erections, machinery, &c., would be necessary in the Pond at the mouth of the sewer to test my plan, I am by them referred to your Board, and they have promised to concur in any arrangement that you may be pleased to sanction and agree to with me for that object.

I have prepared a plan of works, such as I would suggest should be adopted at the King's Scholars' Pond Sewer, showing how the heavy sewage would deposit itself, facilitated by the artificial means applied to it, and the impurities being all removed, the water, in a pure state, would pass off into the Thames at all times of the tide. This plan I shall have much pleasure in submitting to the consideration of your committee appointed upon such matters, as also to your engineer, and shall be glad of an early appointment for that purpose, waiting which,

I am, &c.
(signed) *C. F. Kirkman.*

To the Metropolitan Board of Works.

P.S.—Since writing the above I have seen, by reports in the public journals, that a memorial from the inhabitants of Balham, Clapham-common, Wandsworth-common, and Battersea, has been presented to your Honourable Board, calling your attention to the fact that the Falcon Brook Sewer, which is open and pestilential, has become much worse, and praying that you will take steps to convert it into a covered sewer.

I find, also, that the rate-payers of the Fulham district complain, they having discovered that drainage in their district can only be obtained by means of open ditches charged with gases destructive to human life, or by cesspools, through which their springs of pure water are polluted.

Both these evils may be obviated without much difficulty, and at small expense. The latter case, I apprehend, will come within the powers of the Sewage Manure Company's Act.

The plan that I ask permission to test at the King's Scholar's Pond Sewer may be adopted at any outfall, or reservoir, on mud banks, or at any place suitable for the construction of works within which the process may be carried on.

(Copy.)

LETTER from the Metropolitan Board.

1, Greek-street, Soho,
Dear Sir, 18 June 1859.

THE Board, with the view of deciding whether any of the schemes for the deodorisation and utilisation of sewage which have been submitted to them possess practical value for objects connected with the functions of this Board, having referred those schemes to two eminent chemists for consideration, those gentlemen are unable to test the relative merits of the several suggestions laid before them without further information; and with that purpose they have expressed a desire that they should be made acquainted with the nature of the agent you propose to use, and also to have placed at their disposal a sample, in such quantity as will enable them to make experiments on a sufficient scale to demonstrate its value. If you are therefore willing that your plan should be subjected to this investigation, and do not object to furnishing the required information, I am instructed to request that you will be good enough to describe the nature of the agent you employ, and to send a sample to this office.

I am &c.
(signed) *E. Woolrych*,
Clerk of the Board.

C. F. Kirkman, Esq.

(Copy.)

LETTER to the Metropolitan Board.

Argyll-street, Regent-street,
Gentlemen, 29 June 1859.

I HAVE been from home, and only just now received your letter of the 18th inst. In reply, I write that there was not in my letter to your Board anything that should have induced it to imagine that I had any patent or specific for ascertaining the chemical contents of sewage, or any unknown mode by which offensive matter could be denuded of its perfume. My notions were limited to a common-sense view of the question, and not to abstruse scientific inquiries upon so simple an affair.

Last year we had a Select Committee appointed to consider the state of the Thames, and Mr. Goldsworthy Gurney's plan of purifying it. The main object of Mr. Gurney's plan, as by the Report of the Committee, was to discharge all the sewage of this great metropolis into the water of the Thames, within the metropolis itself. He never made so great a mistake in his life. I may be wrong, but my object is to keep it all out of the Thames; we can then treat it properly and profitably; and so satisfied am I of my facts, from long experience, that I offered to back them with a large outlay, if you would afford me the opportunity of doing so at one of the largest and most offensive sewers under your control. The contents of this sewer, with others, was placed, by Act of Parliament, under the direction of the Sewage Manure Company, and to this body you referred me last summer. The Directors gave me a meeting in November, when I submitted to them my plans; and they were willing to concede to me all they could, viz., the contents of the sewer; they had no power over the sewer itself, but offered to concur with your Board, to give effect to any arrangement you might wish to make with me.

My letter to you of November 27th, not yet answered, was communicating the result of my meeting with the Board of the Sewage Manure Company, and asking permission to test my plan, at my own cost, in the large festering cesspool therein named; and I then offered to submit my plan in detail to the consideration of your Board, and to your own engineer. All I asked for the devotion of my time, my mind, and my money was, that you should grant me permission to keep out of the Thames that which you were throwing into it, because of no value to you—that which was polluting the river, and some day may be destructive of life to a fearful extent.

This was my only hope of remuneration for the risk I was willing to run, the cost I was ready to incur for the public good. I had then both leisure and unoccupied capital; now my time is fully engaged, my capital satisfactorily employed; and I should not feel inclined to divert my attention from present pleasurable engagements, without some certainty of generous aid to test, and liberal compensation upon satisfactory proof of the efficacy of my plan: but I am willing to enter into an arrangement with your Board collectively, with either of them, or with your engineer individually, or any other energetic competent person; will fully inform them or him of my plan of operation, upon the understanding and agreement that if my plan, or any modification of it, be adopted at any one of the sewers, or at either of your contemplated great outfalls, that I shall receive a liberal monied compensation in gross, or a small royalty per ton, upon all sewage saved and converted to agricultural, horticultural, or floricultural uses.

Waiting your reply,

I am, &c.
(signed) *C. F. Kirkman.*

Gentlemen, Lambeth, 4 July 1860.

REFERRING to your advertisement of May 8th, "for tenders or proposals from any person who may be desirous of contracting for, deodorising, or otherwise treating the sewage conveyed by the main outfall sewers of the metropolis, so as to render the same innocuous, or for removing and disposing of such sewage, with the view to its application to agricultural or other purposes," I beg to say that I have given more than 20 years' consideration to the sewage question, and that I have arrived at certain practical results that cannot fail to supply the conditions required for the sewage system of London, in the deodorisation and utilisation of the flow of matter, with due regard to sanitary regulations; but I find, on making inquiry at your office, that your plans and works are not sufficiently advanced to permit any prudent man either to devise efficient detail or form any estimate of the means to effectuate a contract. The works are inchoate, and legislation is incomplete, so that change of one or the other might involve ruinous consequences to a contractor who would now engage upon an economical basis for the purification of the sewage or its removal; however, I make bold to state, and I undertake that, subject to compensation for the result of such changes, I can contract for the objects above stated by the advertisement.

I shall not only remove all noxious solids and gases from the sewage, but provide that the fluid that will pass into the river shall be thoroughly

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divested of deleterious and offensive properties, pure and limpid; and, at the same time, the residuum shall be available to the fullest extent, and in the most advantageous form, for fertilisation, at a price greatly conducive to economy in agriculture—conditions that, I venture to assert, no one else can actually satisfy.

The question naturally ensues, At what cost and in what form is this desideratum attainable? The *modus operandi* is the result of my experience of more than 20 years' investigation; and as its most profitable application is to the sewage of London, you will no doubt excuse my stipulating for an adequate remuneration before you require me to place it at the disposal of your engineers.

The cost of the requisite works will, in fact, effect a vast economy of outlay in the operations which, I am informed, you have contemplated at the present outfalls. The future value also of the sewage will be enhanced largely by my plan; therefore it is not unreasonable, I presume, to think that I should ask a fair proportion of the saving in works to be effected, not exceeding 20 per cent., and a small royalty on the quantity of the sewage sold, in case you employ myself or any other person to carry out the principle I may divulge, which I am satisfied has not yet been suggested to your Board; nor do I think it probable it will be communicated in answer to your advertisement by any other person.

It certainly can do no irreparable mischief to delay a decision on the subject; nay, I feel assured you will adopt this course as a wise policy. In that event, if my general proposition be entertained, I shall be ready, when required, to submit a more definite statement of the terms on which I shall place myself entirely at the disposal of your Board, and your engineers, to operate as I have mentioned.

I have, &c.,
(signed) *C. F. Kirkman.*
To the Metropolitan Board of Works.

Gentlemen, Lambeth, 12 July 1860.

By the morning papers of Saturday I was informed that, excepting the offer by way of prospective proposal, only two tenders have been made for the sewage that will pass through the Northern Main Outfall Sewer to Barking Creek, in pursuance of your advertisement in that behalf.

It appears also that those tenders, and two letters, including mine, were referred to your Committee. An error in giving my name in the report obliges me thus early to obtrude on your attention to say that the proposal said to be Mr. C. T. Ker's should be stated as Mr. C. F. Kirkman's, as I then did and now beg to subscribe myself. I avail myself of this same occasion to remark upon the insufficiency of the terms of the two tenders above referred to. It may be computed that the outfall will yield over 300 tons of solid sewage per day, if properly dealt with. Its value may be estimated at a much higher standard than either 5 *l.* or a peppercorn rent per annum.

Should you agree to my general terms, I shall demonstrate that there will be a great saving of your terminus expenses, on which I rest my claim to compensation out of that fund. If my plan be not adopted in totality, or in part or principle, you are not prejudiced, and I gain nothing from that source. Again, the solid sewage, as I prepare it, will be of a much higher quality for agricultural purposes than it otherwise would be, and it will soon insure a full demand by farmers and gardeners, both at home and abroad. On this point my profit will depend on a justification of this view.

It is scarcely possible to estimate the quantity of solid sewage which is passing into the Thames daily, but all of it may be saved and returned to the soil to produce the elements of food; and if you finally approve my comparatively inexpensive mode of treatment, I shall be content with a moderate royalty per ton. This is sufficient to contrast my offer with its competitors; in the latter you find terms which leave nothing but the lowest nominal consideration for the concession you have to grant, and in neither case does the applicant profess to render the sewage more suitable or more economical for agricultural consumption than existing means, which raises the question whether the parties are competent to continue the operation. For, manifestly, if the demand cease on a price remunerative to the contractor, either from the inferiority of his manure or through the competition in value of other and superior articles, ruinous loss and final failure must ensue, which would leave the risk of future operations a charge on the Board of Works, and possibly frustrate the purpose of the vast outlay now in progress. Further, there appears no proposal to render the liquid overflow into the Thames pure and innocuous, a point of no less importance than permanency and improvement under the contract.

On the other hand, by my plans you will not only save an annual income more than sufficient to pay interest upon the whole of the outlay for main-drainage and other incidental expenses, but insure an improvement in the manufactured or intercepted sewage, equally conducive to commercial advantage as beneficial to agriculture. The success of the system of drainage will also be permanently maintained, whilst the river will be comparatively completely purified.

I ask you to risk nothing in this; I only require, with that natural precaution which every reasonable member of the Board will, I am sure, sanction, to be satisfied, by a preliminary agreement, that if my plans are adopted, entirely or partially, that I shall be compensated for 20 years' application to this object, and that after I have devised efficient arrangements others shall not be employed to effectuate them, as is too frequently alleged in public business with Governmental bodies and companies.

In granting me that indulgence of a conditional contract, no detrimental delay ensues. Six months will suffice for the completion of details, and then, if my plan fail to demonstrate the certainty of the results I promise, the question will not be prejudiced, nor will your Board be in a worse condition than at present; for obviously the rival tenders are unavailable at the present moment.

I have, &c.
(signed) *C. F. Kirkman.*
To the Main Drainage Committee,
Metropolitan Board of Works.

METROPOLITAN SEWAGE.

DESCRIPTION of WORKS for the Treatment of the Sewage at the Outfall Sewers of the Metropolitan Main Drainage Scheme as by the annexed Plan, pursuant to the Conditions of the Advertisement of the Metropolitan Board of Works for Tenders for the Disposal of the Sewage, on 8th May 1863.

IT is proposed that the sewage in its ordinary flow shall be taken from branch sewers near to the great outfalls (*see* plan of ground and outfall sewer with position of reservoirs now constructing at Barking Creek), and passed to the works at *e* in longitudinal section EF (fig. 2 in the annexed plan), where it will pass through gutlets into the tanks (KK). The matter is here subjected to approved applications for deodorisation, and then it passes successively into a given number of subsiding pans or trays (*o o* and *p p*). From these the aqueous portion, with the manurial ingredients—viz., the ammonia, potash, phosphoric acid, and magnesia, that is to say all the important elements of manure—is then diverted into the clarifying tanks (*v v*), from which it passes through, after the process peculiar to my system, to the discharge channel or conduit, by which it may be delivered in a perfectly clear and innocuous state into the river.

C. F. Kirkman.

A. D. 1861.—6 September.—No. 2,229.

OBTAINING MANURE FROM SEWAGE.

LETTERS PATENT to *Charles Felton Kirkman*, of Palace New Road, Lambeth, for the Invention of "Improvements in obtaining Manure from Sewage, and in the Apparatus employed therein."—Sealed the 4th March 1862, and dated the 6th September 1861.

PROVISIONAL SPECIFICATION left by the said Charles Felton Kirkman at the Office of the Commissioners of Patents with his Petition, on the 6th September 1861.

I Charles Felton Kirkman, of Palace New Road, Lambeth, do hereby declare the nature of the invention for "Improvements in obtaining manure from sewerage, and in the apparatus employed therein," to be as follows:—

This invention has for its object improvements in obtaining manure from sewerage and in the apparatus employed therein for these purposes. The sewerage coming from a sewer is caused to flow or spread over an extended surface, so that the depth shall be comparatively small and the flow sluggish. The surface over which the waters from the sewer are caused to spread is divided into several sections, and each section is formed with longitudinal gutters, along which the waters from the sewer flow and deposit any grit or heavy matters in the gutters. Provision is made for changing the section or sections from time to time, in order that the section or sections which have become charged with sand, grit, or heavy matters may be cleansed or emptied previous to being again used. The waters flow from the section or sections into one of a series of tanks or reservoirs, where any deodorising materials which are employed are applied to them. From this reservoir or tank the waters flow by a syphon into another and deeper tank or reservoir. The first-mentioned tanks are used in succession, and the waters flow into them in succession, and do not flow therefrom until the water-level rises above the bend of the syphon, and then they flow therefrom into the deeper tank till the first-mentioned are empty. The waters are then raised or pumped out of the deeper tank or reservoir, and distributed over a series of trays or shallow vessels, the flow of the waters in these trays being very slow or sluggish. In these trays the valuable matters are deposited from the waters. The bottoms of these trays are of sandstone or of other suitable porous or permeable matter, so that the filtration may take place through them. The deposited matters, after the flow of the waters has been diverted into and over other similar trays, is allowed to dry, and the drying is facilitated by dusting over them boghead coke or burned clay or gypsum, or other dryers which are suitable to be thrown on to land; and in order to prevent the matters deposited from the waters adhering to the trays, they are first dusted over with dry burned clay or gypsum, or other matters suitable for making manure. The deposited matters in the tray after a time are to be cut or divided into pieces, which are to be turned over or raised on edge to facilitate their being well dried. The waters passing over the trays then flow into filter-beds of burned clay or gypsum, or other matters suitable for producing manure by absorbing the fertilising matter in solution in the waters. It is preferred that these filters should be so formed as to cause the waters alternately to descend through and then to rise up through the filtering materials used.

SPECIFICATION in pursuance of the Conditions of the Letters Patent filed by the said Charles Felton Kirkman, in the Great Seal Patent Office, on the 6th March 1862.

To all to whom these presents shall come, I Charles Felton Kirkman, of Palace New Road, Lambeth, send greeting:

WHEREAS Her Most Excellent Majesty Queen Victoria, by Her Letters Patent bearing date the sixth day of September, in the year of Our Lord one thousand eight hundred and sixty-one, in the twenty-fifth year of Her reign, did for herself, her heirs and successors, give and grant unto me, the said Charles Felton Kirkman, Her special license that

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that I, the said Charles Felton Kirkman, my executors, administrators, and assigns, or such others as I, the said Charles Felton Kirkman, my executors, administrators, and assigns, should at any time agree with, and no others from time to time, and at all times thereafter during the term therein expressed, should and lawfully might make, use, exercise, and vend within the United Kingdom of Great Britain and Ireland, the Channel Islands, and Isle of Man, an invention for "Improvements in obtaining manure from sewerage and in the apparatus employed therein," upon the condition (amongst others) that I the said Charles Felton Kirkman, my executors or administrators, by an instrument in writing under my or their or one of their hands and seals, should particularly describe and ascertain the nature of the said invention, and in what manner the same was to be performed, and cause the same to be filed in the Great Seal Patent Office within six calendar months next and immediately after the date of the said Letters Patent.

Now know ye that I, the said Charles Felton Kirkman, do hereby declare the nature of the said invention, and in what manner the same is to be performed, to be particularly described and ascertained in and by the following statement thereof, that is to say:—

This invention has for its object improvements in obtaining manure from sewerage, and in the apparatus employed therein.

Description of the Drawings.

Figure 1 shows a plan of apparatus arranged according to the invention; figure 2 shows a longitudinal section; figure 3 a transverse section taken at A. B. in figure 1; and figure 4 a transverse section taken at C. D. in figure 1. In these figures the same letters of reference are used to indicate the same parts.

For these purposes the sewerage or sewage coming from a sewer is caused to flow or spread over an extended surface, so that the depth shall be comparatively small and the flow sluggish. The sewerage or sewage is first received into the gutter (*e e*), out of which there are openings (at *f f*) each capable of being closed by a slide or gate (*g*), so that the waters coming from a sewer may be divided into several streams, as will readily be understood by reference to the drawings. The surface over which the waters from the sewer are caused to spread is divided into several sections (*h h h*), and each section is formed with longitudinal gutters (*i i i*), along which the waters from the sewer flow and deposit any grit or heavy matters in the gutters. Provision is made as before mentioned, by means of the slides or gates (*g g*), for changing the section or sections from time to time, in order that the section or sections which have become charged with sand, grit, or heavy matters, may be cleansed or emptied previous to being again used. The waters flow from the section or sections composed of longitudinal gutters (*i i*) into one of a series of tanks or reservoirs (*k k*) by means of the descending passages (*j j*) at the ends of the first sections (*i i*) into a transverse pipe (j^1) below, and thence through branch pipes (j^2) into one of the tanks or reservoirs (*k k*), where any deodorising materials which are employed are applied to them, such deodorising materials being prepared in one of the tubs (*l*) or other suitable vessel, and from thence supplied to the tanks or reservoirs (*k*) into which it is allowed to flow, and such deodorising matters are well stirred into the waters received into the reservoirs or tanks (*k k*). From one of these reservoirs or tanks (*k*) the waters flow by a syphon (*m*) into another and deeper tank or reservoir (*n*). The first-mentioned tanks (*k k*) are used in succession, and the waters flow into them in succession, and do not flow therefrom till the water-level rises above the bend of the syphon, and then they flow therefrom into the deeper tank (*n*) till the first-mentioned reservoirs (*k*) are empty. The waters are then raised or pumped out of the deeper tank or reservoir and distributed over a series of trays or shallow vats (*o o*), the flow of the waters in these trays being very slow or sluggish. In order that these shallow vessels may be used separately, the waters from the tank (*n*) are pumped into a gutter or trough (o^1), from which there are separate passages (o^2) with slides or gates (o^3). In these trays and in the similar trays (*p p*) the valuable matters are deposited from the waters. The bottoms of these trays are of sandstone or of other suitable porous or permeable matters, so that filtration may take place through them.

In the drawings the bottoms of the shallow trays or vessels (*o o* and *p p*) are shown to be covered with porous tiles resting on uprights (o^4 o^4) at their angles, leaving a space (o^5) below the tiles; and the water from below the tiles is collected by a pipe (o^6), from whence it passes by a pipe or pipes to the drain (*q*), which also receives the filtered water from under the trays (*p p*); the drain (*q*) conducts such filtered water to any place where it may be required.

I would state that the mode of forming the bottoms of these and the other similar trays may be varied, but it is desirable that they should be porous. The deposited matter, after the flow of the waters has been diverted into and over trays (*o o* and *p p*), is allowed to dry, and the drying is facilitated by dusting over the deposited matter in them boghead, coke, or burned clay or gypsum, or other dryers which are suitable to be thrown on to land. And in order to prevent the matters deposited from the waters adhering to the trays, they are first dusted over with dry burned clay or gypsum, or other matters suitable for making manure. The deposited matters in the trays, after a time, are to be cut or divided into pieces, which are to be turned over or raised on edge to facilitate their being well dried. The waters passing over the trays (*o o* and *p p*) then flow into the filter-beds (*r r*) of burned clay or gypsum, or other matters suitable for producing manure by absorbing the fertilising matter in solution in the waters. It is preferred that these filters should be so formed as to cause the waters alternately to descend through and then to rise up through the filtering materials used. It is preferred that these filter-beds should be formed in tanks or vessels divided by partitions (r^1 and r^2), so arranged that when filled up with burned clay or gypsum or other matters, the sewerage waters shall be caused to pass through such materials, and alternately under the partitions (r^1) and over the partitions (r^2) by which the sewage, after having deposited in the trays (*o o* and *p p*) much or all of the matters held in suspension will, by being filtered through the materials in the filter-beds (*r*), be deprived of the remaining manuring or fertilising matters held in solution. The apparatus above described is shown to be arranged to suit land where there is not a sufficient fall between the successive parts of the apparatus, to avoid the necessity of pumping the sewage after being mixed with the deodorising matters; but it will be evident that where the land falls, as on the side of a hill or otherwise, and the depositing trays can be arranged with convenience to flow into the trays (*o o*) from the tanks or reservoirs, the expense of pumping may be dispensed with.

Having thus described the nature of my invention and the manner of performing the same, I would have it understood that what I claim is the apparatus and process herein described for obtaining manure from sewage, or waters coming from sewerage works of cities, towns, and other places.

In witness whereof I, the said Charles Felton Kirkman, have hereunto set my hand and seal this fifth day of March, in the year of our Lord one thousand eight hundred and sixty two,

Charles F Kirkman.
(L.S.)

CORRESPONDENCE relative to the Tender of Mr. *Ellis.*

9, Lincoln's Inn,
Gentlemen, 18 March 1861.

We beg to enlose you an application on behalf of our client, Mr. T. Ellis, the promoter of a company to be called the "London and Provincial Towns Sewage Irrigation Company (Limited)," for a concession of the sewage of London, to which we beg your attention.

Should the Board require further explanation we will be happy to afford it, on receiving an appointment to attend before them for that purpose.

We have, &c.
(signed) *Poole, Johnson, & Co.*
Solicitors to the proposed Company.

To the Honourable the
Board of Works, Spring Gardens.

APPLICATION of Mr. *Thomas Ellis*, of 11A, Hart-street, Bloomsbury-square, Builder and Contractor, to the Honourable Board of Works, for a concession of the Sewage of London, upon the following terms:—

1st. That a Company be formed for the application of the sewage (in a liquid state) to the land.

2d. That the Company receive the sewage of the Board of Works from the outfall tanks at present proposed to be constructed by the Board, and the Company be permitted to use such tanks and reservoirs.

3d. That, for the purposes of distributing the sewage, the Company undertake to erect all necessary machinery, and construct all necessary works.

4th. That previously to the sewage being applied to the land it shall be completely freed from all offensive smell, if so required by the Board of Works.

5th. That all duly appointed officers of the Board of Works shall at all times have free access to the Company's works; and that the Board shall, on their report, have the absolute power (upon giving a written order to that effect) immediately to suspend the further distribution of the sewage, should it at any time be found in a state likely to cause a nuisance, but that such suspension of the works shall at once cease upon the sewage being fully deodorised.

6th. That the Company be empowered to pump any or all of the sewage into the river, provided that from any accident to the machinery or other cause the entire amount of the sewage, or any portion of it, cannot be applied to the land; the Company undertaking in such case that, previously to pumping the sewage into the river, it shall be deodorised and precipitated.

7th. That the Company undertake all liabilities of legal proceedings in case of nuisance in the application of the sewage, or any of the operations of the Company.

8th. That from the revenue derived from the sale of the London sewage, the Company be in receipt of a preference dividend of 5 per cent. upon the amount of the paid-up capital of the Company; the remainder of the revenue, after such deduction, to be equally divided between the Company and the Board of Works.

9th. That the management of the Company be vested in a Court of Directors, one half of whom shall be elected by the shareholders of the Company, and one half nominated by the Board of Works (if they so desire it) from their own body; such last-mentioned Directors only to hold such office so long as they shall continue to be members of the Board of Works.

10th. That the concession of the sewage by the Board of Works shall be in perpetuity, or for such term as the Board of Works has power to grant, and shall be granted to Mr. Thomas Ellis, the promoter of the Company, conditionally upon a Company being formed, upon the above terms, or such alteration of them as may be mutually agreed on between all the parties concerned.

9, Lincoln's Inn,
Sir, 6 April 1861.

On behalf of our clients, the promoters of a proposed Company to be called the "London and Provincial Towns Sewage Irrigation Company," we some days since made an application to the Board of Works for a concession of the sewage of London. Should that concession be granted we are desirous, if possible, to secure your services for the Company as their engineer, thinking that from your high professional character and your intimate acquaintance with the subject your services would be most valuable. We are also of opinion that the engineer to the Board of Works should be the engineer to the proposed company, as this arrangement would prevent any possiblity of a clashing of plans between the two, and would, with the other conditions which we have already submitted to the Board, secure for it that control over all our operations to which we think it is entitled. Should our proposal meet your views we should be happy to wait upon you, in company with our clients, at any time most convenient to yourself

We have, &c.
(signed) *Poole, Johnson, & Co.*

J. W. Bazalgette, Esq.
Board of Works, Spring Gardens.

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9, Lincoln's Inn,
4 May 1861.

Sir,

On the 18th day of March last we had the honour to forward to the Board of Works an application on behalf of our client, Mr. Ellis, the promoter of the London and Provincial Towns Sewage Irrigation Company, for a concession of the sewage of London, and we now beg again to draw your attention to the matter, for the following reasons.

A Special Act of Parliament is absolutely required to enable the proposed Company to take the necessary lands on which to construct the reservoirs, lay down pipes, &c.; and in order that application may be made to Parliament next February, for such an Act, the plans, &c. must be lodged with the Board of Trade next November, before which time the capital must be subscribed, the country surveyed, and all other arrangements completed.

Even now there is barely time to accomplish all this; but when it is recollected that there is only actually to the end of July next to raise the capital, as during vacation (*i.e.*, the months of August, September, and October) nothing could be done, the matter becomes even more pressing.

Should the Company not be able to complete its arrangements in time to go to Parliament for an Act in February next, it will be thrown over till February 1863; and as it will take, in all probability, about three years to complete the works, it would in this latter case, even under the most favourable circumstances, be impossible to take the sewage from the Board of Works before 1866.

At present the money-market is in such a state that no difficulty will be experienced in obtaining the necessary capital; out should we be prevented from coming before the public until next year, such a state of things may, and most probably will, then exist in Europe as greatly to unsettle the money market, and render it utterly impossible to raise the amount of capital required to carry out the objects of the Company.

Such a result, in completely preventing the formation of any company proposing to take the sewage of London from the Board of Works, until probably many years after the completion of all the main drains, might entail much inconvenience and trouble upon the Board itself.

We earnestly therefore trust that early consideration may be given to the application for a concession which we have had the honour to submit.

We have, &c.
(signed) *Poole, Johnson, & Co.*

John Thwaites, Esq.,
Metropolitan Board of Works,
Spring Gardens.

The Manor House,
South Myms, Barnet,
4 June 1861.

Dear Sir,

Mr. Ellis has prepared a statement to be laid before the Committee of your Board, and accompanied it with very elaborate detailed calculations, which, so far as I am a competent judge, carry out his views. He and myself called this morning on Dr. Brady, who will go through the papers and then forward them to you, and will be much obliged if you will kindly bring them under the notice of the Committee and afford us an opportunity of giving any explanation that may be required.

I have, &c.
(signed) *H. D. Poole.*

J. Thwaites, Esq.

Warwick Terrace,
5 June 1861.

My dear Thwaites,

I forward for your kind attention and consideration the plan of Mr. Ellis, who is most anxious to have your decision as soon as possible. Mr. Ellis wishes to settle upon the Directors of his Company before the breaking up of Parliament.

I am, &c.
(signed) *John Brady.*

J. Thwaites, Esq.

11a, Hart-street,
Bloomsbury-square, W.C.,
5 June 1861.

Gentlemen,

Your works connected with the Main Drainage of London being now so far advanced, a question arises of great interest both to you and the ratepayers—

What is to be done with the sewage when your works shall be completed?

Is it to be emptied into the Thames a total loss, and at an expense of deodorisation, &c. of not less than 300,000 *l.* a-year, which must of course be raised by annual rate?—

Or is it to be utilised for the benefit of the ratepayers and the public?

If it is to be utilised as a manure, it must be in one of two ways, either in a solid or a fluid state.

Already various schemes have been brought before the public for extracting the manure from the sewage and solidifying it; but the projectors have failed to show that they did extract the entire manure from the sewage, or that such works when carried on upon a large scale could be made to pay as a commercial speculation.

It follows, then, that if the sewage of London is to be utilised for agricultural purposes, it must be by using it in a fluid state, and I now beg leave to offer for your consideration the outline of my plan for so disposing of it.

I propose to take the sewage from your outfall tanks, allow it to flow into wells constructed for that purpose, from whence it will be pumped by Cornish steam-engines through large iron mains up to covered reservoirs placed on ground outside London, of sufficient height to give a good jet to the sewage when delivered on the land.

From the large covered reservoirs the sewage will flow by gravitation through mains into the agricultural districts, avoiding the near neighbourhood of London.

From the mains submains will be laid down on each farm, at the expense of the landlord or tenant; and at suitable points on each farm hydrants will be erected, from which the sewage will be delivered through moveable bitumenised paper pipes and flexible hoses on to the land.

The large covered reservoirs being always kept charged, and the sewage flowing from them by gravitation, the parties using it can apply it to their lands at any time of the day or night.

The experience of my Lord Essex, in his experiments with sewage on his demense at Watford, and of other parties elsewhere, leads me to think that no complaints would be made of nuisance from the smell of the sewage when applied to the land in its natural state, the earth being so powerful a deodoriser; but to prevent the possibility of any annoyance to the public on that ground, I propose to deodorise it during the hot months, and at such other times as the Board of Works shall direct; the Board having authority, by their servants, to enter the premises of the proposed Company at any hour of the day or night, and to stop the works if the sewage shall be found in a state likely to cause a nuisance.

And as a further guarantee against nuisance, as well as to give the Board of Works a full control over the entire working of the Company, I propose that the Board of Works shall have power to nominate from their own body one-half of the directors of the Company; those gentlemen so nominated to be *ex-officio* directors of the Company so long as they remain members of the Board of Works. (*Vide* "Suggestions for a Concession," herewith sent, marked A.)

Another objection may be made, but one which does not affect my plan, that the sewage, when supplied to the lands, might contaminate the springs and rivers.

On this point I would observe that, if the sewage of London was delivered in enormous quantities upon a very restricted area, and at such a low price as to induce a lavish and wasteful expenditure of it, some inconvenience might possibly be experienced by its overflowing into the rivers; but, unless the quantity so overflowing was very great, its presence in the rivers would not be felt in any way, as the aquatic plants, performing one of the functions intended for them by nature as purifiers of the waters in which they grow, would quickly absorb a very large amount of the manure; and the water itself, it should be borne in mind, is one of our most powerful deodorisers.

As to the springs, they would not receive injury from the sewage unless enormous quantities were put on the land (if even then), as the sewage would have to pass through the earth and be filtered in the best deodoriser known before reaching them; and I am the more confident that this is the case, from the fact that no complaints of this description have been made in any of the districts where experiments with sewage have been carried on. But having this possible though improbable objection in view, I have made my calculations for so large an area as only to allow of a supply per acre of less than one-half the quantity required for proper cultivation; by which arrangement, amongst other advantages, I secure that the sewage shall be applied to the land carefully and without waste, thus preventing all chance of its being allowed to flow into the rivers. (*Vide* Appendix to detailed estimate of plans herewith, and marked B.)

And, with reference to that document, I would wish to observe that I have confined myself, in all cases, to ascertained facts, the results of the experiments of my Lord Essex, as appears by his Lordship's letter to me of the 11th of last month, as well as the experiments of other parties elsewhere. (*See* copy letter C.)

And finally, with reference to nuisance in general, or any other cause of complaint, I would observe that in the Act of Parliament, which the Company will require to enable it to carry out its objects, such provisions shall be made as shall be satisfactory to the Board of Works, as proposed in my "Suggestions for a Concession," herewith sent, marked A. No uneasiness, therefore, should be felt by the Board on that point, as a Company capable of carrying into execution so gigantic an undertaking, involving such an outlay, must of necessity hold such a position as to offer to the Board of Works the most perfect guarantee for the due performance of all its engagements.

I also forward with this my rough estimate of the cost of the necessary works for utilising the sewage of London and working the same, giving the details of all my calculations, marked B.

The capital required will amount to 6,500,000 *l.*, on which I am prepared to prove an income will be received which, after deducting the cost of working, will return over 27 *l.* per cent., provided the sewage be sold at 2 *d.* a ton, which is less than the value of it, as certified by Messrs. Hoffman and Witt.

The profits derived from the sale of the sewage I propose shall be divided thus, between the Board of Works and the Company:—

£. 5 per cent. per annum on the paid-up capital to be first deducted as a preference dividend for the shareholders, and the balance to be equally divided between the Board of Works and the Company.

This arrangement will place a sum of over 700,000 *l.* per annum at the disposal of the Board of Works, either for the reduction of taxation on our house property or the beautifying of the metropolis. This sum, together with the sum of at least 300,000 *l.* a-year which it would cost the Board of Works to empty the sewage into the Thames after deodorising it, and which sum must in that case be raised by an additional annual rate, will make a sum of not less than 1,000,000 *l.* per annum saved to the ratepayers of the metropolis by the adoption by the Board of Works of my plan for utilising the sewage of London.

I am, &c.
(signed) *Thomas Ellis.*

To the Honourable the
Board of Works.

(A.)

APPLICATION of Mr. *Thomas Ellis*, of 11 A, Hart-street, Bloomsbury-square, Builder and Contractor, to the Honourable Board of Works, for a Concession of the Sewage of London upon the following Terms:—

1. That a Company be formed for the application of the sewage (in a liquid state) to the land.

2. That the Company receive the sewage of the Board of Works from the outfall tanks at present proposed to be constructed by the Board, and the Company be permitted to use such tanks and reservoirs.

3. That for the purpose of distributing the sewage,

App. No. 14. sewage, the Company undertake to erect all necessary machinery, and construct all necessary works.

4. That previously to the sewage being applied to the land, it shall be completely freed from all offensive smell, if so required by the Board of Works.

5. That all duly appointed officers of the Board of Works shall at all times have free access to the Company's works, and that the Board shall, on their report, have the absolute power (upon giving a written order to that effect) immediately to suspend the further distribution of the sewage, should it at any time be found in a state likely to cause a nuisance, but that such suspension of the works shall at once cease upon the sewage being fully deodorised.

6. That the Company be empowered to pump any or all of the sewage into the river, provided that from any accident to the machinery or other cause, the entire amount of the sewage, or any portion of it, cannot be applied to the land, the Company undertaking in such case that, previously to pumping the sewage into the river, it shall be deodorised and precipitated.

7. That the Company undertake all liabilities of legal proceedings in case of nuisance in the application of the sewage, or any of the operations of the Company.

8. That from the revenue derived from the sale of the London sewage, the Company be in receipt of a preference dividend of five per cent. upon the amount of the paid-up capital of the Company; the remainder of the revenue, after such deduction, to be equally divided between the Company and the Board of Works.

9. That the management of the Company be vested in a Court of Directors, one-half of whom shall be elected by the shareholders of the Company, and one-half nominated by the Board of Works (if they so desire it) from their own body; such last-named directors only to hold such office so long as they shall continue to be members of the Board of Works.

10. That the concession of the sewage by the Board of Works shall be in perpetuity, or for such term as the Board of Works has power to grant, and shall be granted to Mr. Thomas Ellis, the promoter of the Company, conditionally upon a Company being formed, upon the above terms, or such alteration of them as may be mutually agreed on between all the parties concerned.

(B.)

THE LONDON and PROVINCIAL TOWNS SEWAGE IRRIGATION COMPANY (LIMITED).

DETAILED ESTIMATE of PLAN, with APPENDIX, on MAXIMUM AREA to profitably absorb the whole Sewage.

ERECTION.

Engines and Buildings—(Constant).

THE reservoirs to be constructed by the Board of Works will, as far as can yet be learned, be of the following dimensions:—

North side - - 12 acres in area, by 15·5 ft. deep.
South side - - 7 acres in area, by 15·5 ft. deep.

These reservoirs are to contain the average amount of sewage generated in 12 hours; consequently their cubic content will form the limit of the bulk of sewage to be pumped in 12 hours.

Content of North Side reservoir—

$$= 12 \text{ acres} \times 15{\cdot}5 \text{ ft.}$$
$$= (12 \times 43{,}560) \text{ square ft.} \times 15{\cdot}5 \text{ ft.}$$
$$= 8{,}102{,}160 \text{ cubic feet.}$$

Divide this by 12 × 60 for the quantity per minute:—

$$= \frac{8{,}102{,}160}{12 \times 60}$$
$$= 11{,}253 \text{ cubic feet.}$$

Multiply by ·02841 for the same in tons—

$$= 11{,}253 \times {\cdot}02841$$
$$= 319{\cdot}8 \text{ tons.}$$
$$= 716{,}352 \text{ pounds per minute.}$$

This is supposed to be lifted to Hampstead (431 feet high), called 460 feet, in order to meet correction for depth of wells or tanks from which the sewage may be pumped:—

$\therefore$ Nett HP. for the north side.
$= 716{,}352 \times 460 \div 33{,}000$
$= 9{,}985{\cdot}5$

Content of south side reservoir—

$= 7$ acres $\times$ $15{\cdot}5$ ft.
$= (7 \times 43{,}560)$ square ft. $\times$ $15{\cdot}5$ ft.
$= 4{,}726{,}260.$

Divide this by 12×60 for the quantity per minute—

$$= \frac{4{,}726{,}260}{12 \times 60} = 6{,}564{\cdot}2 \text{ cubic feet.}$$

Multiply by ·02841 for the same in tons—

$= 6{,}564{\cdot}2 \times {\cdot}02841$
$= 186{\cdot}5$ tons.
$= 417{,}760$ lbs. per minute.

This is supposed to be lifted to Shooter's Hill (412 feet high), called 440 feet, in order to meet correction as much as possible for depths of wells or tanks from which the sewage may be pumped:—

$\therefore$ Nett HP. for the south side.
$= 417{,}460 \times 440 \div 33{,}000$
$= 5{,}570{\cdot}1.$

Nett HP. for north side = 9·985·5
ditto - south side = 5,570·1

TOTAL - - 15,556

For friction, spare power, &c. $\frac{15}{8}$ of this nett HP. is assumed to be the requisite gross HP. [" *Hughes* on Waterworks."]

$= \frac{15}{8} \times 15{,}556$
$= 29{,}167 =$ gross HP.

By Messrs. Hocking & Son, Engineers.

Cost of erecting engines and buildings 40 *l.* per H.P. $= 40 \times 29{,}167 =$ £. 1,166,680

Mains.—(Constant.)

The rate of flow maintained in the mains is assumed to be 2·5 miles per hour.

Volume flowing through the mains on the north side in 12 hours.

$= 8{,}102{,}160$ cubic feet.
$= 675{,}180$ cubic feet per hour.
Letting $x =$ bore of main—
$x \times 2{\cdot}5 = 675{,}180$ cubic feet.
$x \times 13{,}200$ feet $= 675{,}180$ cubic feet.
$\therefore x = 51{\cdot}15$ square feet.
= vertical area of main.

Dividing this into a set of 3—

$\frac{51{\cdot}15}{3} =$ Area of each pipe in the set.

$= 17{\cdot}05$ square feet.
Let $d =$ diameter.
$d^2 \times {\cdot}7854 = 17{\cdot}05$
$d^2 = 21{\cdot}7087$
$\therefore d = \sqrt{21{\cdot}7087} = 4{\cdot}66$ feet.

The distance from Barking outfall to Hampstead is about 13 miles. This then would be the length of a single main; but in the present case, the main being resolved into 3, will give for a total length of pipe,

3×13 miles $= 39$ miles.

Volume flowing through the mains on the south side in 12 hours—

$= 4{,}726{,}260$ cubic feet.
$= 393{,}855$ cubic feet per hour.
Letting $x =$ bore of main.
$x \times 2{\cdot}5 = 393{,}855$ cubic feet.
$x \times 13{,}200$ feet $= 393{,}855$ cubic feet.
$x = 29{\cdot}84$ square feet.
= vertical area of main.

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Dividing this into a set of 2—

$\frac{29\cdot84}{2} = 14\cdot92$ square feet.

= area of each pipe in the set.

Letting d = diameter.

$d^2 \times \cdot7854 = 14\cdot92.$

$d^2 = 18\cdot9967$

$\therefore d = \sqrt{18\cdot9967} = 4\cdot36$ feet.

The distance from Plumstead outfall to Shooter's-hill is about four miles.

$\therefore$ Total length of pipe $= 2 \times 4$ miles $= 8$ miles.

By Mr. R. Barrow, iron founder—

4·66 feet diameter pipe weighs 15·64 cwt. per yard.
4·36 feet ,, ,, 14·44 cwt. ,,

Now 39 miles of 4·66 feet diameter pipe—

= 15·64 cwt. × 1760 × 39
= 1,376 tons 6 cwt. × 39
= 53,676 tons - - - (*a*)

And, 8 miles of 4·36 feet diameter pipe—

= 14·44 cwt. × 1760 × 8
= 10,166 tons. - - - (*b*)

(*a*)	= - - -	53,676 tons
(*b*)	= - - -	10,166 ,,
	TOTAL - -	63,842 ,,

This at 5*l.* 10*s.* per ton - - - - - -	= -	£. 351,131
Laying, &c. &c. at 2*l.* per yard (82,720 yards) -	= -	165,440
TOTAL - - -		£. 516,571

Reservoirs and Wells.—(Constant.)

The reservoirs and wells are considered to be in content, equal to twice the sum of contents of the Board of Works' north and south side reservoirs.

= 2 × (8,102,160 + 4,726,260) cubic feet.
= 25,656,840 cubic feet.
= inner content of the wells and reservoirs together.

In order to approximate to the mass of brickwork, &c., entirely irrespective of the form or the position of the wells and reservoirs, it is necessary merely to deduce results from any form of equal content.

Therefore, supposing the form to be cylindrical, and the depth 30 feet, letting x = area of reservoir—

$x \times 30 = 25{,}656{,}840$ cubic feet.

$x = 855{,}228$ square feet.

$= 19\cdot7$ acres.

Letting d = diameter—

$d^2 \times 7{,}854 = 855{,}228$ square feet.

$d^2 = 1{,}088{,}907\cdot56$

$\therefore d = \sqrt{1{,}088{,}907\cdot56}$

$= 1{,}043\cdot51$ feet.

For the outer content, let the whole (sides, top, and bottom) be bounded by 1·5 feet of brickwork—

$= \{1{,}043\cdot51 + 2\,(1\cdot5)\times\}^{2}\cdot7854 \times \{30 + 2\,(1\cdot5)\}$

$= 1{,}046\cdot51^{2} \times \cdot7854 \times 33$

$= 1{,}095{,}183\cdot18 \times \cdot7{,}854 \times 33$

$= 860{,}156\cdot87 \times 33$

= 28,385, 177 cubic feet.

Volume excavated—

$= \frac{1}{2}\,(1{,}046\cdot51^{2} \times \cdot7{,}854 \times 31\cdot5)$ cubic feet.

$= \frac{1}{2}\,27{,}094{,}941\cdot4$

= 13,547,471 cubic feet.

Divide

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Divide by 27 for cubic yards = 501,758 cubic yards.
This at 1*s.* per yard - - - - = £. 25,088.

Outer content - - - = 28,385,177 cubic feet.
Inner content - - - = 25,656,840 ditto.

Difference in cubic feet - - 2,728,337 ditto.

Divide by 306 for rods = 8,916.
This at 12*l.* per rod = 106,992*l.*

	£.
Excavation - - - - - -	25,088
Brickwork - - - - - -	106,992
TOTAL - - - £.	132,080

The arching and support of the roof of the reservoirs or reservoir, puddling and concreting the bottom, &c. though not specified in the calculation of this estimate, are, in amount, doubtlessly covered by the maximum amount of brickwork employed as datum.

Distributing Mains.—(Varying).

North side sewage per day - - - = 16,204,320 cubic feet.
Multiply by ·02841 for tons - - - = 460,364·7 tons per day.
Multiply by 365 for amount per annum = 168,033,115 tons.

At 500* tons per acre, this will irrigate 336,066 acres, or 525 square miles.

* *Vide* Appendix.

South side, sewage per day - - - - = 9,452,520 cubic feet.
Multiply by ·02841 for tons
= 268,546 tons.
= 98,019,326 tons per annum.

At 500 tons† per acre, this will irrigate 196,038 acres, or 306·2 square miles.

† *Vide* Appendix.

These areas will have to be doubled, for the reason that about one-half only is available for sewage application, the remaining half being roads, towns, &c. This is derived from the following:—

The roads, towns, &c. were cut from a map in six different instances, and weighed, apart from the other portions of the map—

1st Experiment, roads, &c. - -	7·5 grs. - -	other land -	12·5 grs.
2d - ditto - - - -	4·5 „ - -	ditto - -	14· „
3d - ditto - - - -	15· „ - -	ditto - -	30· „
4th - ditto - - - -	11· „ - -	ditto - -	17·5 „
5th - ditto - - - -	9·5 „ - -	ditto - -	17·5 „
6th - ditto - - - -	12· „ - -	ditto - -	27· „
Giving a mean of - - -	9·9 - -	- - -	19·7 „

or, the roads, towns, &c. occupy a space as nearly as possible equal to one-half the whole area. From the impossibility of quite correctly cutting out minute roads, &c., and from the inaccuracies of the map in delineating the roads to a scale, it is evident a certain amount of error exists; this, however, is immaterial, as it will go to meet the allowance made for land, upon which, from uncertain or changeable causes, the sewage would not be applied.

The areas therefore for which calculations concerning the mains will have to be made, are (instead of 525 square miles and 306·2 square miles), 1,050 square miles and 612·4 square miles for the north and south sides respectively. In order to avoid the country taken up by the metropolis and the river, the areas in both cases are taken as segments of circles, as follows:—

On the north side the boundary radii are supposed to run due E. and S. W., or to form with the circumference $\frac{5}{8}$ths of the whole ⊙. On the south side the boundary radii are also supposed to run due E. and S. W., but in this instance to form with the circumference $\frac{3}{8}$ths of the whole ⊙.

From this, it is evident the north side area will be portion of a circle whose $\frac{5}{8}$ths area is 1,050 square miles, and whose whole area therefore—

= 1,680 square miles.
Letting d = diameter.
$d^2 \times {\cdot}7854 = 1680.$
$d^2 = 2139{\cdot}04.$
$d = \sqrt{2139{\cdot}04} = 46{\cdot}2$ miles.
radius 23·1 miles.

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The south side area will be portion of a circle, whose $\frac{3}{8}$th area is 612·4 square miles, and whole area 1632·8 square miles, from whence $d^2 = 2077{\cdot}92$—

$$\text{and } d = \sqrt{2078{\cdot}94} = 45{\cdot}6 \text{ miles.}$$
$$\text{radius} = 22{\cdot}8 \text{ miles.}$$

From these radii the average fall of the mains per mile in feet may be—

$$\frac{460}{23{\cdot}1}\text{ ft. - and - }\frac{440}{22{\cdot}8}\text{ ft.} = 20 \text{ very nearly. (Call this H.)}$$

The distributing mains are supposed to be so arranged over the country (under the public roads), as to average not greater frequency than one mile of pipe to one square mile of surface of country. For ascertaining the required diameter of the pipes, two hydrants are considered to be open at the same time in each square mile. Now, dividing the whole areas into 6 by concentric arcs of circles, of 4, 8, 12, 16 and 20 miles radius, it is evident a main traversing the first area will have to supply the whole number of openings throughout the entire 23 miles.

or 23 times 2 openings = 46
for the 2d area 19 " " = 38
" 3d " 15 " " = 30
" 4th " 11 " " = 22
" 5th " 7 " " = 14
" 6th " 3 " " = 6

Each hydrant opening is taken equal to 3 inches diameter, or ·25 feet; and the flow to equals 4 miles per hour. Consequently, the quantity leaving the main in each area, will be the quantity from each opening × the number of openings in the area.

Quantity from each opening $= {\cdot}25^2 \times {\cdot}7854 \times \frac{4 \times 5280}{60} = 17{\cdot}28$ cubic feet per minute.

Quantity leaving the mains in the—

1st area = 17·28 × 46 = 795 cubic feet very nearly.
2d " = " × 38 = 657 " "
3d " = " × 30 = 518 " "
4th " = " × 22 = 380 " "
5th " = " × 14 = 242 " "
6th " = " × 6 = 104 " "

The diameter of the mains is computed from the formula—

$$D = \frac{2{\cdot}3\ V^2.}{H.}$$

D being the diameter of the pipe in feet.
V " velocity in feet per second.
H " inclination in feet per mile.

["*Hughes* on Waterworks."]

For the 1st area—

Let V = 4·19 or 2·86 miles per hour.

$$\therefore D = \frac{2{\cdot}3 \times 4{\cdot}19^2.}{20}$$
$$= 2{\cdot}02 \text{ feet.}$$

The flow per minute through this pipe—

$$= 2{\cdot}02^2 \times {\cdot}7854 \times 251{\cdot}4 \text{ feet per minute.}$$
$$= 806 \text{ cubic feet.}$$

The required flow is 795 cubic feet.

Therefore, a 2·02 feet diameter pipe is adapted to the first area.

For the 2d area—

Let V = 4·03 or 2·75 miles per hour.

$$\therefore D = \frac{2{\cdot}3 \times 4{\cdot}03^2}{20}$$
$$= 1{\cdot}9 \text{ feet.}$$

The flow per minute through this pipe—

$$= 1{\cdot}9^2 \times {\cdot}7854 \times 242 \text{ feet per minute.}$$
$$= 685 \text{ cubic feet.}$$

The required flow is 657 cubic feet.

Therefore a 1·9 feet diameter pipe is adapted to the 2nd area.

For the 3d area—

Let $V = 3{\cdot}87$ or $2{\cdot}64$ miles per hour.

$$\therefore D = \frac{2{\cdot}3 \times 3{\cdot}87^2}{20}$$

$= 1{\cdot}7$ feet.

The flow per minute through this pipe—

$= 1{\cdot}7^2 \times {\cdot}7854 \times 232$ feet per minute.
$= 527$ cubic feet.

The required flow is 518 cubic feet.

Therefore a 1·7 feet diameter pipe is adapted to the third area.

For the fourth area—

Let $V = 3{\cdot}65$ or $2{\cdot}49$ miles per hour.

$$\therefore D = \frac{2{\cdot}3 \times 3{\cdot}65^2}{20}$$

$= 1{\cdot}53$ feet.

The flow per minute through this pipe—

$= 1{\cdot}53^2 \times {\cdot}7854 \times 219$ feet per minute.
$= 403$ cubic feet.

The required flow is 380 cubic feet.

Therefore, a 1·53 feet diameter pipe is adapted to the fourth area.

For the fifth area—

Let $V = 3{\cdot}35$ or $2{\cdot}29$ miles per hour.

$$\therefore D = \frac{2{\cdot}3 \times 3{\cdot}35^2}{20}$$

$= 1{\cdot}29$ feet.

The flow per minute through this pipe—

$= 1{\cdot}29^2 \times 7854 \times 201$ feet per minute.
$= 261$ cubic feet.

The required flow is 242 cubic feet.

Therefore, a 1·29 feet diameter pipe is adapted to the fifth area.

For the sixth area—

Let $V = 2{\cdot}8$ or $1{\cdot}9$ miles per hour.

$$\therefore D = \frac{2{\cdot}3 \times 2{\cdot}8^2}{20}$$

$= 0{\cdot}9$ feet.

The flow per minute through this pipe

$= {\cdot}9^2 \times {\cdot}7854 \times 168$ feet per minute.
$= 107$ cubic feet.

The required flow is 104 cubic feet.

Therefore a ·9 feet diameter pipe is adapted to the sixth area.

North side:—

Extent of first area $= \frac{5}{8} \odot$ of 4 miles radius.
$= \frac{5}{8} (8^2 \times {\cdot}7854)$
$= \frac{5}{8} \times 50{\cdot}26$
$= = 31{\cdot}4$ square miles - - (Call this α).
" second area $= \frac{5}{8} \odot$ of 8 miles radius $- \alpha$
$= \frac{5}{8} \times 201{\cdot}06 - \alpha$
$= 94{\cdot}1$ square miles - - (Call this β).
" third area $= \frac{5}{8} \odot$ of 12 miles radius $- (\alpha + \beta)$.
$= \frac{5}{8} \times 452{\cdot}39 - (\alpha + \beta)$.
$= 157{\cdot}2$ square miles - - (Call this γ).
" fourth area $= \frac{5}{8} \odot$ of 16 miles radius $- (\alpha + \beta + \gamma)$.
$= \frac{5}{8} \times 804 - (\alpha + \beta + \gamma)$.
$= 219{\cdot}8$ square miles - - (Call this δ).
" fifth area $= \frac{5}{8} \odot$ of 20 miles rad. $- (\alpha + \beta + \gamma + \delta)$.
$= 282{\cdot}9$ square miles - - (Call this ϵ).
" sixth area $=$ whole area $- (\alpha + \beta + \gamma + \delta + \epsilon)$.
$= 264{\cdot}4$ square miles.

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South Side:—

" first area = $\frac{3}{8}\odot$ of 4 radius.
= 18·8 square miles - - - (Call this α').

" second area = $\frac{3}{8}\odot$ of 8 miles — α'.
= 56·6 square miles - - (Call this β').

" third area = $\frac{3}{8}\odot$ of 12 miles radius — $(\alpha' + \beta')$.
= 94·2 square miles - - - (Call this γ').

" fourth area = $\frac{3}{8}\odot$ of 16 miles radius — $(\alpha' + \beta' + \gamma')$.
= 131·9 square miles - - (Call this δ').

" fifth area = $\frac{3}{8}\odot$ of 20 miles radius — $(\alpha' + \beta' + \gamma' + \delta')$.
= 169·7 square miles - - (Call this ε').

" sixth area = whole area — $(\alpha' + \beta' + \gamma' + \delta' + \varepsilon')$.
= 141·2 square miles.

Total of 1st Areas = 31·4 + 18·8 = 50·2 square miles
" 2d " = 94·1 + 55·6 = 150·7 "
" 3d " = 157·2 + 94·2 = 251·4 "
" 4th " = 219·8 + 131·9 = 351·7 "
" 5th " = 282·9 + 169·7 = 452·6 "
" 6th " = 264·4 + 141·2 = 405·6 "

The 1st areas	requiring	2·02	feet diameter	pipe
2d	"	1·9	"	"
3d	"	1·7	"	"
4th	"	1·53	"	"
5th	"	1·29	"	"
6th	"	0·9	"	"

From Mr. Barrow, Iron Founder:—

	Cwts.	qrs.		Tons.	
2·02 feet diameter pipe weighs	6	2	per yard or	572	per mile
1·9 " "	6	1	"	550	"
1.7 " "	5	2	"	484	"
1·53 " "	5	0	"	440	"
1·29 " "	4	1	"	374	"
0·9 " "	3	0	"	264	"

Therefore

				Tons.
50·2 miles	of 2·02	feet diameter	pipe weighs	28,714
150·7 "	1·9	"	"	82,885
251·4 "	1·7	"	"	121,678
351·7 "	1·53	"	"	154,748
452·6 "	1·29	"	"	169,272
405·6 "	0·9	"	"	107,078
			TOTAL	664,375

This at 5 *l.*[*] per ton - - - - - =	£. 3,321,875
Average laying, &c., at 5 *s.* per yard (2,925,824 yards)	731,456
	£. 4,053,331

Contingencies—(Varying.)
Say £. 201,088.

WORKING.

Working the Engines—(Constant.)

The gross HP. as shown, is - - 29,167; two-thirds of this is considered equivalent to the work to be done.

$\frac{2}{3} \times 29{,}167 = 19{,}445.$

The average cost of working each horse power is 15 *l.* per annum.

("*Hughes* on Waterworks."

Therefore total cost = 19,445 × 15 = 291,675 *l.*

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[*] Where the elevation sufficiently reduces the pressure in the pipes, it is proposed to use bituminised paper pipes, these pipes being on the average not more than one-half the price of iron. These elevations not being known, and to, as much as possible, simplify the estimate, the calculations are based upon the supposition of the mains being iron, and the cost 5 *l.* per ton.

"*Deodorization*"—(Constant.)

By Bazalgette 11,000 *l.* would be required to "deodorize" the sewage of the "Western District," which equal 1,586 cubic feet per minute = 1,141,920 cubic feet per 12 hours.

Total amount of sewage in 12 hours = 12,828,420 cubic feet:

$\therefore$ 1,141,920 : 12,828,420 :: 11,000 *l.* : x.
From which cost = £. 123,575.

Salaries and Rent.

Say £. 15,000.

Labour expended upon the Engines themselves is allowed for in "Cost of Working the Engines."

RECAPITULATION.

	£.	£.
Cost of Erection:		
Engines and Buildings - - - - -	1,166,680 p. 364	
Mains, &c. - - - - - - -	516,571 p. 365	
Reservoirs and Wells - - - - -	132,080 p. 366	
Distributing Mains, &c. - - - - -	4,053,331 p. 367	
Contingencies - - - - - - -	201,088 p. 370	6,069,750
Cost of Working:		
Working the Engines - - - - -	291,675 p. 370	
"Deodorization" - - - - - -	123,575 p. 371	
Salaries and Rent - - - - - -	15,000 p. 371	430,250
Requisite Capital - - - - £.		6,500,000

Revenue derived from a rental of 2 *l.* per acre per annum, from all lands irrigated by the Company—
= Total number of acres irrigated × 2.
= 532,104 × 2
= 1,064,208 *l.*

This—working expenses—
= return to the Company without any deduction for the Board of Works.
= 1,064,208 − 430,250.
= 633,958 *l.* or 9·7 per cent.

This with the proposed reduction for the Board of Works, becomes—
479,479 *l.*, or 7·35 per cent., for the Company:
154,479 *l.*, or 2·35 „ „ Board of Works.

Revenue derived from the sale of the sewage, at the rate of 2 *d.* per ton—
= Total number of tons × 2.
= 266,052,441 × 2
= 2,217,104 *l.*

This—working expenses—
= return to the Company without any deduction for the Board of Works.
= 2,217,104 *l.* − 430,250.
= 1,786,854 *l.*, or 27·5 per cent.

This, with the proposed reduction for the Board of Works, becomes—
1,055,927 *l.*, or 16·25 per cent., for the Company:
730,927 *l.*, or 11·25 „ „ Board of Works.

At a rate of 1½ *d.* per ton the return without deduction for Board of Works—
= 1,232,568 *l.*, or 18·9 per cent.

With the deduction it is 778,784 *l.*, or 11·95 per cent., for the Company:
453,784 *l.*, or 6·95 „ „ Board of Works.

At a rate of 1 *d.* per ton, the return without deduction is—
= 678,302 *l.*, or 10·5 per cent.

With the deduction it is 501,651 *l.*, or 7·75 per cent., for the Company:
176,651 *l.*, or 2·75 „ „ Board of Works.

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Appendix.

To find the quantity of sewage manure likely to be absorbed on a given area, we must first ascertain the quantity of farmyard dung which can, under the most favourable circumstances, be produced on the same area: it being understood that the lands on that area are self-supporting, that is, no food is consumed by the cattle except that grown on the land, and no manures purchased.

We already know, by a long course of experiments made by the best farmers of the day, the exact quantity of farmyard dung per acre required to produce first-class crops. If, then, on land entirely self-supporting that amount can be produced, it follows that no sewage or extraneous manures will be required; but if it cannot, then the difference between the two amounts is the quantity of sewage per acre likely to be absorbed on a given area, provided it can be supplied to the farmer at as low a price as any other manure. If it can be furnished at a lower price, then we may with much certainty calculate upon its almost entirely taking the place of all other extraneous manures on that area.

Now, the higher land is farmed the greater will be the quantity of manure produced on that land, and therefore the smaller the deficiency to be supplied. Let us, therefore, see the maximum quantity of manure which, under the best systems of cultivation (if self-supporting) can be produced on a given extent of land.

The latest and best authority on the point is "Morton's Cyclopædia of Agriculture," published in 1855. At page 289, vol. ii., we find it stated that "There are three marked systems of cultivation which have established themselves in this country—viz., the four-course or Norfolk system, the five-course or Northumberland system, and the six-course or East Lothian system. By the first or Norfolk system we have on a farm (say for convenience of calculation) of 120 acres—30 acres of wheat, 30 of barley, and 30 of clover and Italian rye grass. Assuming a fixed amount of bushels of grain for the different rotations, and calculating from a great number of data the quantity of straw yielded per bushel on well-cultivated land, and also the quantity of green crops grown, we shall be able to arrive at an approximation as to the whole manure actually produced and made on a farm under the different systems specified.

"The average yield of wheat upon well-cultivated farms is, according to an average taken from a great number of experiments where no artificial manures had been applied, 30 bushels, yielding a fraction more than 100 lbs. of straw to every bushel of grain. Of oats the yield may be taken at 48 bushels, each bushel yielding 78 lbs. of straw. Of barley the yield was a little more than 41 bushels, or say 40 bushels, and 70 lbs. of straw to the bushel: Swedes, 17½ tons; yellow turnips, 20 tons, and white 22½ tons. Of beans the yield and proportion of straw to the grain is more variable, and having few published data to go by, we assume the yield to be 28 bushels and 30 hundreds of straw.

"Upon a farm of 120 acres cultivated upon the four-course system there will be of straw and turnips as follows:—

	T.	cwt.	qrs.	Tons	cwt.	qrs.
"30 acres of wheat - 27 cwt. of straw per acre -	40	10	0			
"30 ditto barley - 25 cwt. per acre - -	37	10	0			
" 7½ ditto hay - 30 ditto - - - -	11	5	0			
"Dry food and litter - - - - - -				89	5	0
" 7½ acres grass consumed - 120 cwt. - -	45	0	0			
"15 ditto turnips indoors - 20 tons - -	300	0	0			
"15 ditto ditto fed off - - - - -		—				
"15 ditto grass ditto - - - - -		—				
"120 a. 15 acres of aftermath consumed green 61 cwt.	45	0	0			
				390	0	0
TOTAL Year's Food - - -				479	5	0

" Supposing the stock indoors to consist of four horses to work the farm, and 16 bullocks, box-fed, the distribution of the food and litter would be as follows :—

	Tons cwt. qrs.	*Tons cwt. qrs.*
" Four work-horses will consume of hay as fodder in eight months, or 243 days, 1½ stone each per day.	9 2 1	
" Straw as litter for the same period, 1 stone per day each.	6 0 2	
" Green food for 122 days in summer, 6 stone each per day.	18 6 0	
" Straw as litter during that period, 1 stone each per day.	3 1 0	
		36 9 3
" Sixteen full-sized cattle will consume and fatten upon 210 lbs. of turnips each per day, for 210 days.	300 0 0	
" Litter and fodder for the same period, at 3 stone each per day.	63 0 0	
		363 0 0
" Eight bullocks will consume of cut grass in four months, 168 lbs. per day.	71 14 0	
" Litter for same time, 19 lbs. each per day - -	8 1 1	
		79 15 1
		479 5 0

" By the five-course, 120 acres:

" This rotation in Norfolk is—first, grass ; second, grass pastures ; third, wheat ; fourth, turnips ; and fifth, barley.

" The following may be taken as a fair average of this rotation :—

	Tons cwt. qrs.	*Tons cwt. qrs.*
" 48 acres of wheat, oats, and barley, in equal proportions, at 27⅔ cwt. of straw per acre.	66 8 0	
" 7½ acres of hay, 30 cwt. per acre - - -	11 5 0	
" Dry food - - - - -	- - -	77 13 0
" 3 acres of grass consumed by horses, 120 cwt.	18 6 0	
" 37½ acres fed off (grass) - - - - - -	—	
" 24 acres of turnips consumed by cattle in boxes	280 0 0	
		298 6 0
		375 19 0
" Winter's food for four horses ;		
" Hay, 243 days, 1½ stone each - - - - -	9 2 1	
" Straw litter for same time, 1 stone each per day -	6 0 2	
" Summer food :		
" Cut grass for 122 days - - - - - -	—	
" Six stone each per day - - - - - -	18 6 0	
" Straw litter for same period, 1 stone each per day	3 0 0	
		39 9 3
" Fifteen cattle consuming at the rate of 200 lbs. each will finish in 209 days.	280 0 0	
" Fodder and litter - - - - - - -	58 15 2½	
		338 15 2½
		375 5 1½

" Six-course farm of 120 acres :—This course in Scotland is—first, wheat ; second, turnips ; third, barley ; fourth, grass ; fifth, oats ; sixth, potatoes and beans, or one-half corn and one-half green crops. The distribution and sequence of the crops is different in Norfolk. There the six-course consists of—first, wheat ; second, barley ; third, turnips ; fourth, barley ; fifth, grass ; sixth, grass or corn and green crops, half-and-half. In both cases the turnips occupy one-sixth of the land, so that the manure-making materials in the latter will only vary in amount in proportion to the quantity of grass consumed in the green state or made into hay.

" The Scotch rotation is selected in preference, because of the equal distribution of the crops, and also because of no two white crops follow in succession.

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"The amount of food and consumption may be stated as follows:—

	Tons	cwt.	qrs.	Tons	cwt.	qrs.
"20 acres of wheat, at 27 cwt. of straw per acre	27	0	0			
"20 ditto barley, at 25 cwt.	35	0	0			
"20 ditto oats, at 30 cwt.	30	0	0			
" 7 ditto hay, at 30 cwt.	10	0	0			
"19 ditto beans, at 30 cwt.	15	0	0			
Total dry fodder				107	0	0
" 3 acres of grass consumed by horses, 120 cwt.	18	0	0			
"10 acres fed off	—					
"20 acres of turnips consumed indoors, 20 tons	400	0	0			
"19 ditto potatoes sold off	—					
"10 ditto aftermath	—					
"Consumed indoors 60 cwt.	30	0	0			
				448	6	0
"Total green food				555	6	0
"Winter's food for horses:						
"Four work-horses' hay, 243 days, 1½ stone each per day.	9	2	1			
"Straw litter for same period, 1 stone each per day	6	0	2			
"Summer food for horses:						
"Cut grass for 122 days	—					
"Six stone each per day	18	6	0			
"Straw litter, 1 stone each per day	3	1	0			
				36	9	3
"Twenty-one cattle 200 lbs. of turnips each for 213½ days.	400	0	0			
"Fodder and litter for same period, 3 stone each per day.	84	1	1			
				484	1	1
"Summer food for cattle:						
"Four cattle 168 lbs. grass each per day for 100 days.	30	0	0			
"Straw litter for 100 days, 1½ stone each per day	3	15	0			
				33	15	0
				554	6	0
"One ton of straw over				1	0	0
				555	6	0

"By the four-course rotation, the whole turnips, grass, and straw consumed by the cattle amount in round numbers to 393 tons, which gives 295 tons of manure, and, with the litter added, amounts to 345 tons. The dung from the food consumed by the horses and taken from the stalls will depend greatly on the time occupied at work or in the stable; but, taking our former data to govern us, the dung actually collected from four horses, fed as already stated, will be rather more than 34 stone annually. Adding the whole dung, urine, and litter together, the result is 379 tons as the total amount of manure made on a farm of 120 acres, farmed on the four-course shift, or fully 12½ tons per acre for the 30 acres of green crop. By the five-course the number will stand thus:—turnips and consumed fodder, 300 tons = 225 tons of manure + litter 40 tons = 265 tons of manure, which added to that of the horses give 299 tons altogether, or nearly 12½ tons per acre for the 24 acres of green crop.

"By the six-course rotation, turnips, grass, and litter consumed = 458 tons = 343½ tons of manure + 60 tons of litter = 403½ tons of manure, which added to that by the horses give 437½ tons altogether, or nearly 11 tons of manure per acre for the 40 acres of green crop. It will however be observed, with regard to these data, that by the first rotation the land is dunged every fourth year, in the second every fifth year, and in the third every third year, or twice during the rotation.

"By the four-course 3·16 tons of manure are made annually for every acre on the farm.

"By the five-course 2·5, and by the six-course 3·64 tons.

"It is evident, therefore, that the six-rotation produces more manure than either of the others, notwithstanding that one-sixth of the green crop (potatoes) is annually sold off the farm."

Now, according to Stephen's "Book of the Farm," published in 1851, the following green crops should receive,—

"Parsnips, 25 tons of farmyard dung per acre in the drills, and four cwt. of guano sown over the drills.

"Carrots. The quantity of manure applied should be 25 tons of farmyard dung, and two cwt. of guano per acre.

"Cabbage. As the cabbage requires much manure, 20 tons to the acre of farmyard dung should be given, and at least two cwt. of guano sown by hand over the drills.

"Potatoes require 25 tons of farmyard dung to the acre.

"Kohl-rabi. With 16 tons of good farmyard dung, and four or five cwt. of sulphated bones to the acre, a crop of from 20 to 30 tons may be expected to be raised. A sprinkling of two cwt. of guano to the acre around each plant, would tend to increase the bulk materially.

"Turnips. When farmyard dung alone is used to manure the turnip crop, the quantity applied generally differs from 12 to 15 tons to the acre, according to the sort of turnip. The Swedish variety receiving the larger quantity, and the white the smaller.

"In the neighbourhood of towns much more manure is applied, as much as 32 loads, of at least 15 cwt. each of town manure to the acre, and upwards of 20 tons of farmyard dung. The more dung the turnip crop receives, it will yield the heavier crop; still, if the farmer depend entirely upon the sources of the farm for manure, he cannot apply a large quantity to one crop without depriving others of their fair share."

From this it appears that to obtain good crops we must give not less than 25 tons of farmyard manure per acre; but for the purposes of this inquiry, and to be well within the truth, let us say 22 all round as a standard.

Now, we have already seen that on a farm of 120 acres, cultivated on the self-supporting system, there can only be produced, under the most favourable circumstances by the four-course system, 379 tons, or 12½ tons per acre for the 30 acres under green crop. This will be 9½ tons short of the proper quantity per acre (22), or 285 tons on the 30 acres.

Now, one ton of farmyard dung, value 5 *s.*, is equal to 30 tons of sewage, therefore 285 tons of farmyard dung deficient = 7,550 tons of sewage. That, then, is the exact quantity of sewage which is required on the 30 acres of green crop, in addition to the utmost amount which can be manufactured on the farm.

By the five-course system, we get 299 tons, or nearly 12½ tons to the acre, on the 24 acres under green crop, leaving a deficiency also of about 9½ tons per acre, or 240 tons on the 24 acres of green crop, equals 7,200 tons of sewage.

By the six-course system, we get 437½ tons of farmyard dung, or nearly 11 tons per acre, on the 40 acres under green crop. The deficiency in this case amounting to 440 tons on the 40 acres = 13,200 tons of sewage.

But we have not as yet considered the quantity of manure, which, by practice, it has been found desirable to apply to the other crops grown on the remainder of the 120 acres.

By the four-course system, there would be in addition to the 30 acres of green crop, 30 acres of wheat, 30 acres of barley, and 30 acres of clover and Italian rye-grass.

Now, Lord Essex, who has for some time rented the sewage of the town of Watford, writes to me: "On wheat I have only tried it once as an experiment. On two acres I applied 60,000 gallons each (about 260 tons), equal to a depth of 2·5 inches, and the result, as against two adjoining acres, was a clear gain of 1 *l.* 7 *s.* per acre in corn and straw. I should use it more extensively for wheat if I could spare it from my rye-grass." If, then, we apply a dressing of 260 tons of sewage per acre on the 30 acres of wheat, we will require 7,800 tons, and a like dressing for the 30 acres of barley, or 7,800 tons. On the Italian rye-grass, Lord Essex informs me that he gives eight dressings, of 260 tons per acre each, with the greatest success. These dressings would require 64,400 tons of sewage for the 30 acres of clover and Italian rye-grass. Thus, for the crops grown on the farm, excluding the green crop, there would be required 79,200 tons of sewage, or, with the 7,550 tons required for the green crop, in addition to the farmyard dung, 86,750 tons in all, or nearly 712 tons per acre—equal 6·8 inches.

By the five-course system, there would be 48 acres of wheat, oats, and barley, in equal proportions. If we dress this with 260 tons to the acre, we will require 12,480 tons; 48 acres of grasses—this dressed eight times with 260 tons per acre, each dressing gives us 98,840 tons; and the 24 acres of turnip, for which the manure of the farm is deficient, 9½ tons per acre, or 240 tons = 7,200 tons of sewage: making the total amount of sewage required for the 120 acres farmed on the five-course system, 118,520 tons, or over 987 tons per acre = a depth of 9·3 inches.

By the six-course system, we have 60 acres of wheat, barley, and oats, in equal proportions. One dressing to this of 260 tons to the acre requires 15,600 tons; 19 acres of beans, 260 tons to the acre = 4,940 tons; 21 acres of grasses, 260 tons to the acre, dressed eight times, require 43,680 tons. Then, 20 acres of turnip, deficient 11 tons of dung per acre = 220 tons farmyard dung = 6,600 tons of sewage; 19 acres of potatoes, deficient 11 tons of dung per acre = 209 tons of dung = 6,270 tons of sewage. The entire quantity of sewage required on 120 acres, farmed on the six-course system, is 77,090, or over 642 tons to the acre, equal a depth of 6·4 inches.

Now,

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Now, if we assume for the moment that all the lands included within the area proposed to be irrigated with the London sewage, are farmed in the best manner according to these three systems (they being the best known, and self-supporting), we find that we would require, on an average, over 780 tons of sewage per acre, 7·7 inches in depth, in addition to all the manure that could be produced on the land. But this would not be a correct assumption, as a large proportion of land within the area would be found to be cultivated on other systems; not so manure, producing, and therefore requiring, more sewage; and this more particularly would be found to be the case on permanent grass-land. It has been found that grass-land will absorb enormous quantities of sewage, making returns exactly in proportion to the manure they receive.

On the Craigentinny Meadows, at Edinburgh, as much as 6,500 tons, 5 feet 4 inches deep per acre, is given per annum; but this amount renders the land too soft for grazing it. On land, therefore, devoted to that purpose a less quantity should be used—say, 3,000 tons; but, to be well within the truth, let us say for meadow land 3,000 tons, equal to a depth of 2 feet 5·4 inches; and for grazing, 1,000 tons per acre, equal to a depth of 9·8 inches.

Now, if we divide the entire area that is to be irrigated by the London sewage thus—(say) two-thirds under tillage, requiring 780 tons of sewage, on an average, per acre, and one-third under permanent grass—of this (one-third) two-thirds will be under grazing, requiring 1,000 tons per acre, and one-third meadow, requiring 3,000 tons per acre. This would give us as the general average, over the entire area, 2,186 tons, equal in depth of 1 foot 9·6 inches of sewage to the acre, provided the sewage alone was used in addition to the farmyard dung; but such would not be the case—other manures would still be used as well as the sewage. It is not probable that any one manure could fill the place of all other manures, nor would it be good for the land that it should; but, inasmuch as sewage contains the component parts of all other manures, and as it can be applied at all periods of the growth of the plant, while no other manure can, and especially in hot summers, when a copious use of sewage would produce almost a tropical growth, it is more than probable that on any area where sewage could be had at a reasonable rate, it would supply at least two-thirds of whatever manure was required to be purchased, or 1,457 tons per acre. But as some farmers may, from prejudice, for a time refuse to take it, or, from want of means, be unable, and to allow a margin for undrained lands, &c., let us again reduce this quantity to (say) 1,000 tons to the acre, equal to a depth of 9·8 inches over the entire area.

But, as I consider that it is desirable to keep the supply of sewage under the demand, I have made my calculations for an area of such extent as only to afford a supply of 500 tons to the acre, equal to a depth of 4·9 inches.

(C.)

Copy of Lord *Essex*'s Letter to Mr. *Ellis*.

21, Chesham-street, Belgravia,
Sir, 14 May.

Ever since Lord Malden wrote to you, I have been suffering so severely from tic-doloreux as to be quite unable to attend to any business, and am only now partially recovered.

In reply to your chief question, I beg to state that I apply sewage to meadow grass land, or rather, park grass and Italian rye-grass. Of the former, I have about 35 acres to which I apply it. I give it two dressings in the course of the autumn and winter, each dressing per acre being about 60,000 gallons, which I put on with two hoses in one day, so that I go over the ground twice in about 80 days. The result has been most satisfactory, doubling at least the crop of hay, making it, indeed, almost too heavy to be made.

This last year I have omitted the sewage in consequence.

Italian rye-grass I cut four or five times, watering abundantly after each cutting, besides watering late in the autumn whenever I can do so, and also in the spring, before cutting. The Italian rye-grass has, on an average, at least eight dressings per acre, of about 60,000 gallons each, and this is not too much; on the contrary, wherever, owing to there being a furrow, and thereby more sewage collected, the crop is heaviest.

On wheat, I have only tried it once as an experiment. On two acres I applied 60,000 gallons each, and the result, as against two adjoining acres, was a clear gain of 1 *l.* 7 *s.* per acre in corn and straw. I should use it more extensively for wheat if I could spare it from my rye grass.

In conclusion, if you think it worth your while to go and see my farm at Cassiobury, my bailiff, Mr. Swanston, will be happy to show it to you, and give you any information in his power.

Yours, &c.
(signed) *Essex.*

My great mistake is having laid down far too great an extent of pipeage, something like 200 acres, whereas 50 or 60 would have been quite enough to consume advantageously all the sewage I obtain.

My whole expenses were at least double what they ought to have been, but such is always the fate of pioneers in improvements.

To Thomas Ellis, Esq.,
11A, Hart-street, Bloomsbury-square.

11A, Hart-street, Bloomsbury-square,
17 June 1861.

My dear Sir,

I was surprised to find that objections to my plan for utilising the sewage of the metropolis are entertained by any member of the Board of Works.

Herewith I send you a reply to those objections, hoping that you will have the kindness to direct the Chairman's attention to it.

These objections amount only to three. They are—

1st. That the farmers will not use the sewage manure when brought to their farms, as I have proposed.

2d. That my lifting-power will cost such "an enormous sum" as to prevent the speculation paying.

3d. That my estimates are only on paper, and therefore cannot be relied on.

The first objection goes at once to the root of the entire question of the utilisation of the sewage for agricultural purposes, and for these reasons:—If the sewage is to be utilised as manure, it must be done in one of two ways—either in the solid or fluid state. Now, against every scheme that I have as yet heard of for solidifying the manure contained in the sewage, there have existed, amongst others, the following fatal objections:—

Either that the materials and labour employed for the purpose of separating the manure from the sewage have cost so much that the manure obtained by the process, when sold, would not pay for the manufacture; or, as in Mr. Thomas Wicksteed's patent lime process, the amount of inert matter mixed with the small amount of manure obtained, was so great that it would not pay the farmers to cart it beyond a very limited distance from the manufactory, even if they got it for nothing. And further, that, by none of these processes for solidifying the manure contained in the sewage, could the parties obtain more of the manure than that held in suspension, which amounts only to one-seventh of the entire mass, the remaining six-sevenths of the manure being the quantity held in solution, entirely eluding their grasp. And although the supernatant water in all these cases presented every appearance of perfect purity, still it was largely charged with manure, and in a condition to become in a very short time highly putrescent.

Therefore, all these schemes have been reported against by the most eminent chemists of the day, and as it is not to be supposed that the Board of Works will, in the face of those reports, sanction any of them, more especially as they hold out no legitimate hope of any benefit to the overtaxed ratepayers of the metropolis, or indeed anything but ruin to their promoters, it follows, of necessity, that if the sewage is to be utilized, it must be in the fluid state, by irrigation.

Now, every person having any knowledge of agriculture is well aware that the most beneficial way in which manure can be applied to land is in the liquid state, and that whenever it has been possible for those engaged in agriculture to utilize the sewage of our towns or villages, they have done so. The result has been uniformly a most astounding success, but in no case has a farmer ever been known to refuse it.

I am aware that the failure of "The Metropolitan Sewage Manure Company" may be urged in contradiction to my statement, but if so, I would at once refer any objecting party to Mr. Austin's report on that company, and the reasons of its failure, from which it appears that the company did not supply manure, but only dirty water to the market gardens at Fulham.

How then can it be said in the face of these well-known facts, that the farmers will not use the sewage manure if it is brought on to their lands and sold to them, as I propose, at a lower rate than any other manure known, especially when the confessedly great want of agriculturists is — more manure of any kind.

What evidence can be offered in support of an opinion which, if adopted and acted on by the Board of Works, amounts to a refusal to utilize the sewage of the metropolis in the fluid state, the only way in which (as is certified by the highest authorities) it ever can be utilized with any chance of profit to the ratepayers or to a company; whilst, on the other hand, I am prepared to prove before any board of engineers in the world, that my scheme would produce an annual income of not less than 700,000 *l.* for the relief of the ratepayers, besides a similar sum for the shareholders over and above their preference dividend of five per cent. on the capital.

With reference to the second objection, that the cost of my lifts was "so enormous" as to prevent my speculation paying,

I admit at once that my lift or motive power will cost a very large sum, but why? simply because there is a very large amount of sewage for it to lift, and the more sewege there is to be lifted, and afterwards sold, the larger will be the income of the company.

For my part, I regret that there is not more sewage to be lifted, requiring a larger amount of power, as in that case, the income of the company would be increased in proportion. Let us take a case in point, and suppose that the Great Northern Railway instead of being made, was only now projected, and that the promoter submits his plans and estimates, and his expected returns on the outlay for examination, a portion of his estimated outlay would be for motive power; he would show the number of trains he would run each day, the speed at which he would work them, their weight, &c., &c.; then he would show the amount of motive power required, its cost, and the cost of working it and keeping it in repair. Now, on a railway of such magnitude, the outlay for motive power would be "enormous;" but who would for a moment think of fixing on that one item as an evidence that the speculation must fail; on the contrary, that item would be the very one which would be cited as the best evidence which could be offered of the success of the speculation, as proving the great amount of traffic there would be on the line, unless, indeed, it could be shown to be in excess of the work to be done, and therefore unnecessarily costly. Who, again, would think of singling out that one item from the estimate as a proof that the speculation could not pay, if the estimate proved to a demonstration that there must be a large return upon the outlay? Now, that is precisely my case, the estimates which you have forwarded to the Board of Works in support of my plan, prove to a demonstration that upon my outlay there must be a return of over 27 *l.* per cent. if the sewage is sold for two pence per ton. Now, the cost of my motive power forms, of course, part of those estimates. How, then, in the face of that fact of 27 *l.* per cent., which has not yet been proved to be an error, can it be asserted that the cost of a part of my works would be "so enormous" as to ruin a company?

My estimates cannot be fairly considered, except as a whole, and with reference to the work to be done, and the returns which may fairly be expected.

And now with reference to the third and last objection,

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objection, that my estimates are only on paper, and cannot be depended on, I would observe, that they have been reduced to writing, for the purpose of being tested. And I solicit, nay challenge, the most minute examination into them, merely asking that it may be open, public, and unprejudiced; I say unprejudiced, because I am well aware of how much I have to contend against, in putting forward a theory contrary to the report of Mr. Thomas Wicksteed, who has so strongly given his opinion against the scheme for utilitising, in a fluid state, the sewage of the metropolis. This report has done an incalculable amount of injury by inducing the public, and perhaps the Board of Works, to believe that the sewage cannot be utilitised in a fluid state, as a profitable commercial speculation, but which report I am with confidence prepared to prove to be utterly fallacious, incorrect in its engineering, incorrect in its calculations, and from beginning to end entirely unsound. If I fail to do this, I shall not ask the Board of Works to trouble themselves further with my plans, for if Mr. Thomas Wicksteed is right, I must of necessity be wrong. All I ask for is a hearing, and I am sure, that if granted, it will be a patient and impartial one, and I, therefore, have every confidence in the result.

Yours, &c.
(signed) *Thomas Ellis.*

To John Brady, Esq., M.P.,
Warwick-terrace, Belgravia.

Lincoln's Inn, 26 June 1861.

Dear Sir,

As we think it possible that your Board would have more confidence in our client, Mr. Ellis, if you were satisfied of his ability to carry out his proposed company, if you should grant his application for a concession of the London sewage, we beg to say that in order to remove any doubts you may entertain on the subject of ways and means, we shall be prepared to deposit 5,000 *l.*, or a larger sum, if required, previously to the scheme being brought before the public, or any expenses being incurred.

We have, &c.
(signed) *Poole, Johnson, & Co.*

J. Thwaites, Esq.,
Metropolitan Board of Works.

London Sewage.

Sir, 13 July 1861.

I am instructed to inform you that a meeeting of the Main Drainage Committee of the Metropolitan Board of Works, will be held at this office, on Tuesday next, the 16th instant, at 2 o'clock p.m., when your proposition for a concession of the sewage of London will be considered; and I am to request the favour of your attendance on that occasion.

I am, &c.
(signed) *John Pollard,*
Clerk of the Board.

Thomas Ellis, Esq.,
11A, Hart-street, Bloomsbury.

10, Lincoln's Inn, 26 July 1861.

Sir,

The consideration by the Board of Works of our client, Mr. Ellis's proposition for a concession of the sewage of London, having been adjourned, to enable him to produce evidence to prove that the sewage could be deodorized without reducing its manurial value, we have to request that you will be pleased to inform the Board of Works, that our client is now prepared with the evidence of a most eminent chemist on that point, which he is ready to produce, if the Board shall consider it necessary at this stage of the proceedings, that he should do so.

Our client informs us that much stress was laid by members of the Board upon this one point, as if on it depended the success or failure of the scheme, but we trust that a calmer re-consideration by those gentlemen of Mr. Ellis's scheme, as a whole, must convince them that they are in error, and that, consequently, the evidence which has been required, as to the effect of the deodorization upon the sewage, in not necessary.

Mr. Ellis proposes to take the sewage from your outfall tanks, as quickly as it flows, and pump it from thence through covered mains, up to a covered, air-tight, and well ventilated reservoirs, which will be so contrived as to prevent all escape of noxious gases, and from whence it will flow through covered pipes into the agricultural districts.

By this plan the sewage, being completely sheltered from the sun, is kept at a low temperature; and as it will be delivered on the land, at the furthest within three days from the date of its passing into his pumps, it is not at all likely to become offensive to the smell, even in the hottest weather.

Sewage thus heated, certainly will not be more offensive when placed upon the land than common farmyard dung, if even as offensive. Now, no one thinks of requiring farmyard dung to be deodorized, we may therefore naturally expect that no demand will be made upon the company to deodorize the sewage; but, should such a demand be made, it can only be during those few days of our summers in which the heat is excessive. Now, if for those few days we were compelled to sacrifice the sewage altogether as manure, still the company could pay a large and very profitable dividend out of the revenue derived from the sewage during the other portions of the year. But we fortunately are not forced to this sacrifice, because if compelled to deodorize, we can do so in a way which will have the effect of increasing, rather than diminishing, the value of the sewage as a manure.

The question of deodorization being thus disposed of, the next point for consideration, we presume, would be our client's estimate of the cost of the necessary works for the utilization of the sewage; and on that point we would wish to observe that Mr. Ellis's estimate, which was furnished to the Board of Works on the fifth of last month, gives the most ample details, thus enabling the Board of Works to detect any error in his calculations, should such exist.

Our clients would be glad to have these estimates submitted to the engineer of the Board, if such an examination should be considered necessary at this stage.

No correct and reliable estimate of the cost of erecting works to utilize the sewage can however be made, until the extent of the area required to absorb the sewage be first ascertained. How this area was to be ascertained correctly seems to have been unknown up to the present, although nothing can be more simple, as is shown by Mr. Ellis in his short essay on cultivation, furnished to the Board of Works in an Appendix to his Estimate.

Standing, then, upon a firm basis, so far as his area is concerned, as proved by his essay, Mr. Ellis proceeds to calculate the cost of his works, and selling the sewage at 2 *d.* per ton, which is less than the value of the manure, as proved by the report of Messrs. Hoffmann and Witt, a value which cannot be questioned, he shows a return so enormous upon his outlay as actually to be injurious to himself as tending to cast a doubt upon the correctness of his calculations.

The Board is invited to consider the large amount of capital which is proposed to be raised for this project of utilizing the Metropolitan sewage. It is proposed to form a Company with a capital of no less than 6,000,000 *l.* sterling, and it is submitted that the promoters are not asking too much from the Metropolitan Board, when they require a distinct concession of the sewage in perpetuity, as it is obvious that a term of 21 years would be utterly inadequate to compensate them for the heavy outlay required to establish their works.

We ask for this concession, on the distinct condition that we obtain an Act of Parliament authorising the construction of the works, and we need not point out that before granting such an Act, Parliament will require at our hands ample proof that the estimate is sufficient, that the outlay of capital affords a reasonable prospect of remuneration; and last, not least, that the great works contemplated, can be executed without inflicting nuisance or injury on the adjacent property.

With reference to the concession of the sewage to our client, without which it is impossible to proceed further in this matter, we would wish to observe that we do not ask for an absolute concession at once, but only for a conditional concession to become absolute, upon the fulfilment of all the conditions which will appear upon the face of it. In the preparation of that agreement, your solicitors of course will carefully guard the rights of the Board of Works and the interest of the ratepayers, and all the conditions of that agreement will afterwards be embodied in the Act of Parliament.

Under no circumstances, therefore, can the Board of Works or the ratepayers be in any way compromised by the Company, or be made liable in any way for any portion of the expense of establishing it, or otherwise.

Our proposition, then, amounts simply to this: we having the most implicit confidence in Mr. Ellis's scheme and his calculations, ask your Board to put us in such a position as will enable us to test that scheme. Should the public agree with us in our opinion, and should we succeed in establishing the Company, the ratepayers of the metropolis will, under the agreements of the concession, become entitled to a large share of our profits, without in any way incurring any risks. That share, we believe, will not be less than 700,000 *l.* per annum. Should we fail in raising the necessary capital to establish the Company, then the loss will fall upon us, and not upon the Board of Works or the ratepayers.

We are deeply impressed with the idea that it is impossible for us to make the Board of Works a more equitable proposition, or one more entirely in the interest of the ratepayers.

In order to prove to the Board of Works our good faith, and our ability to bring this matter properly before the public, we will be content that the concession be granted to our client on the terms that the Company shall not be advertised until the Board of Works shall have previously approved our Board of Directors, and been satisfied that the directors of our Company have at their disposal sufficient funds to enable them fairly to bring the matter out.

In conclusion, we would wish to draw the attention of the Board of Works to the fact, that if we are to go to Parliament next Session for an Act, we must go prepared to give our notices in the beginning of November, and to deposit our plans, &c., not later than the 30th of that month, and that an immense amount of labour has to be gone through before these plans are made, and other necessary preparations completed, for all which there is even now barely time; but should any further delay take place, we must of necessity be late, and thus be thrown over for another year; such a delay may, and most probably will, postpone indefinitely the establishment of such a Company as we project, requiring a large capital, which could only be raised under a conjunction of the most favourable circumstances. It would evidently be impossible to raise such a capital except during a time of profound peace; and in the present unsettled state of affairs on the Continent, it is impossible to say how long this may last. We therefore trust that the Board of Works will be pleased to proceed to a decision upon Mr. Ellis's application for a concession with as little delay as may be consistent with their convenience.

We are, &c.
(signed) *Poole, Johnson & Co.*

To the Chairman of the Board of Works.

11A, Hart-street,
Bloomsbury Square, W.C.,
Sir, 29 July 1861.

The discussion upon my application for a concession of the sewage of London having been adjourned, upon the distinct understanding that it was to be resumed immediately upon my being ready with evidence as to the effect of deodorisation on the manurial value of the sewage, I presume I shall be afforded an opportunity of closing the discussion, on my application, previously to the members of the Board separating for their recess.

My solicitors wrote to you, sir, on Friday last, directing your attention to certain points, and requesting you to inform the Board of Works that I was ready with this evidence if it was still required.

And I have now to request you will be pleased to direct a notice to be given of the day when my application is again to be brought forward—not alone to myself, but also to Dr. Frankland, F. R. S., at his private residence, 42, St. John's Park-road, Haverstock Hill.

Dr. Frankland is, he informs me, about to leave town for the vacation; but, if timely notice is forwarded to him by the Board, he will attend, and I have no doubt will be able to satisfy the Board that so far as deodorisation, manurial value of the sewage, and nuisance are concerned, my scheme is perfectly feasible; and my estimate of the cost of the necessary works having proved beyond question that my plan could be carried out

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out so as to make the scheme a great commercial success, I think I may fairly assume that the proposition I have done myself the honour to make to the Board of Works, and which is so entirely in the interest of the over-taxed ratepayers of the Metropolitan District, which, without engaging them in any sort of responsibility, will place at their disposal, for the reduction of taxation on that district, an annual sum of not less than 700,000 *l.*, will be accepted by the Board of Works, and that I shall at once be permitted to proceed with the arrangements necessary to enable the Company to go to Parliament next Session for their Act.

I have, &c.
(signed) *Thomas Ellis.*

To the Chairman of the
Board of Works.

London Sewage.

Sir, 1 August 1861.

I am instructed to inform you that a meeting of the Main Drainage Committee of the Metropolitan Board of Works will be held at this office on Tuesday next, the 6th instant, at two o'clock p.m., when your proposition for a concession of the sewage of London will be considered; and I am to request the favour of your attendance on that occasion.

With reference to your request that Dr. Frankland should have notice to attend the meeting, I am directed to say that the Committee will no doubt be willing to hear any observations he may have to make on your plan; and if you think his presence desirable, probably you will arrange for his attendance.

I am, &c.
(signed) *John Pollard,*
Clerk of the Board.

Thos. Ellis, Esq.,
11A, Hart Street, Bloomsbury.

Rhyl, North Wales,
Dear Sir, 3 August 1861.

I regret that I have been obliged to leave town, and shall consequently be unable to attend the meeting of the Main Drainage Committee on Tuesday, when, I understand, the proposals of Mr. Ellis, with reference to the sewerage of the Metropolis, will again come under the consideration of the Committee.

I understand the promoters of his company propose to raise a capital of more than six millions sterling for the purpose of establishing works to pump up the whole sewerage of the metropolis from the outlay tanks to be constructed by the Board of Works to such elevations, both on the north and south end of the Thames, as will give a sufficient pressure to distribute the sewerage by gravitation over the surrounding agricultural districts.

They estimate the annual mass of sewerage which will be available at 266 millions of tons, and they calculate that, according to the analysis and statements of Dr. Hoffmann and Mr. Witt, as they appear in the Appendix to the "Referee's Report on Main Drainage, 1857, that the value of this sewerage, when distributed on the land, will be at least 2 *d.* per ton. Hence the following estimate:

	£.
266 millions tons at 2 *d.* - -	2,217,104
Less expenses of pumping, deodorisation, salaries, &c. -	430,250
Leaving profit - - - £.	1,786,854

or more than 27 per cent. on the capital.

The promoters propose that the Metropolitan Board of Works shall be entitled to 40 per cent. of the profit, or about £. 700,000 a year, leaving more than a million to pay interest to the promoters on their capital of six millions sterling.

It must be obvious that if only half this result be realised, namely, if the sewerage, when delivered on the land, be only paid for at half the rate which Messrs. Hoffmann and Witt estimate as its value, the return would still be very large, namely, 350,000 *l.* a year to the Metropolitan Board, and 500,000 *l.*, or more than 8 per cent. to the promoters.

Now, I do not in any way vouch for the accuracy of these estimates, nor do I know whether the promoters will be able to prove them to the satisfaction of Parliament.

But, on this point arises that which I conceive to be the chief feature worthy of attention in the proposition of the promoters.

They ask, I understand, for a concession of the sewerage, in perpetuity, on the following distinct conditions:—

1. The Board to be subject to no risks whatever, but to participate largely in the profits, if any should arise.
2. The promoters to obtain an Act of Parliament which would require them to prove that the capital is *bonâ fide* subscribed, that the estimates are sufficient to execute the works, that there is a reasonable prospect of remuneration for the shareholders, and that the works can be executed and carried on without offence to the contiguous districts.

I think that, guarded by all these conditions, the Board would incur no risk by granting a concession in perpetuity; and I am told that a concession for any short term of years, would not enable the parties to raise the necessary capital.

I forbear to press on the attention of the Committee any of those trite and often-repeated arguments about the value of liquid sewerage as a manure, the necessity for economising a rich and abundant source of ammonia, for which we are now dependent on a few islands on the further shores of the Atlantic, and the wasteful extravagance of deliberately throwing into the sea, and wasting for ever a source of wealth, which lies beneath our feet.

I believe, however, that on a sober examination, this project of dealing with the sewage of the metropolis will not be found so visionary as it may appear at first sight, and, so far as agriculture is concerned, it may be found more reasonable to utilise the ammonia of our shores than to send out our ships to the shores of South America to bring home the dung of birds.

I venture also to submit that an examination by the Committee into the feasibility of the project is not necessary at the present time, as this examination will be made more efficiently and more rigidly by the Parliamentary Committee.

If it were really necessary that the Board should satisfy itself on all the commercial and sanitery questions connected with this scheme, before granting the conditional concession which is asked for, I should advocate the reference of the estimates to the engineer of the Board, and the chemical questions to those eminent chemists who have already been consulted on the deodorisation of the sewage; but believing that the Committee will not consider it necessary to examine all these questions at the present time, as they really affect the promoters and not the Board, and that it will not seek to throw obstacles in the way of parties who wish to deal with the subject in a commercial point of view, I should be prepared, if I could attend the Committee on Tuesday, to vote for a conditional concession of the sewerage on the terms asked for by the promoters.

I am, &c.
(signed) *Samuel Hughes.*
John Thwaites, Esq.

LONDON SEWAGE.

Spring-gardens, S.W.
Sir, 25 October 1861.

I AM instructed to inform you that a meeting of the Main Drainage Committee of the Metropolitan Board of Works will be held at this office, on Tuesday next, the 29th instant, at 12 o'clock at noon, when your proposition for a concession of the sewage of London will be further considered, and I am to request the favour of your attendance on that occasion.

I am, &c.
(signed) *John Pollard,*
Clerk of the Board.
Thos. Ellis, Esq.,
11A, Hart-street, Bloomsbury.

Metropolitan Board of Works,
Spring-Gardens,
Dear Sir, 16 November 1861.

I AM directed to inform you that your communication in reference to the sewage of the metropolis, together with others of a similar nature, having been under the consideration of the Committee, to whom the subject has been referred, they have arrived at the conclusion that before coming to a final decision with respect to any of them, it would be necessary that they should have every possible opportunity for testing the efficiency of the scheme, in an engineering and chemical point of view, and for satisfying themselves that the requirements of the Act of Parliament, relating to the subject, shall in no way be infringed, by the creation of a nuisance in carrying out the works.

With this view, I am to request that you will be good enough to supply a map and sections showing the area of the intended operations, the levels of its surface, and the lines, levels, and sizes of the intended aqueducts, indicating the various kinds of surface soil with which it is proposed to deal, and showing, in detail, what mode of subsoil drainage it is intended to adopt, if any, with the size, depth, and inclination of the several proposed lines of drainage, together with descriptions and particulars of the pumping power to be employed, the number of lifts, and the nature of the outfall.

Also a statement showing the manner in which it is proposed to work the scheme, what kind of powers will be taken for dealing with the land to be operated upon, and how owners and occupiers are to be treated with: what quantity of sewage will be taken up daily, over what quantity of land it will be distributed, what depth it will occupy over that area of land, and if it be intended to employ varying quantities at different seasons, what that variation will be.

Also a full statement of the means of deodorisation, if any, the chemical agents employed, and the details of their mode of application, and what arrangements, if any, it is proposed to make for dealing with the heavy deposit.

Also an estimate, showing separately the cost of the engines and pumps, if any, the conducting pipe or sewer, the distributory and deodorising apparatus, and the subsoil drainage, together with the annual working expenses of each of these three heads of expenditure.

I am, &c.
(signed) *John Pollard,*
Clerk of the Board.
Thos. Ellis, Esq.,
11A, Hart-street, Bloomsbury.

THE METROPOLITAN SEWAGE.

To the Chairman of the Metropolitan Board of Works.

11A, Hart-street, Bloomsbury-square,
Sir, 31 December 1861.

ON the 16th of November I had the honour to receive from the Clerk of the Metropolitan Board of Works a letter, in which I am informed that my communication with reference to the sewage of the metropolis, together with others of a similar nature, are under the consideration of a committee to whom the subject has been referred, and I am requested to give information to the Board of Works on a great variety of points, upon many of which I had already directly, or by my solicitors, furnished the amplest details. I presume, therefore, it is the wish of the Board of Works that all the information in my power to give should be collected by me into one paper, for the greater convenience of reference. With this wish I shall be most happy to comply; but as my reply to Mr. Pollard's communication might not be intelligible to all the members of the Board of Works, unless that communication was at the same time before them, I beg to recall it to your recollection.

Metropolitan Board of Works,
Spring-gardens, S.W.,
Dear Sir, 16 November 1861.

I AM directed to inform you that your communication with reference to the sewage of the metropolis, together with others of a similar nature, having been under the consideration of the committee to whom the subject has been referred, they have arrived at the conclusion that, before coming to a final decision with respect to any of them, it would be necessary that they should have every possible opportunity for testing the efficiency of the scheme in an engineering and chemical point of view, and for satisfying themselves that the requirements of the Act of Parliament relating to the subject shall in no way be infringed by the creation of nuisance in carrying out the works.

With this view I am to request that you will be good enough to supply a map and sections showing the area of intended operations, the levels of its surface, and the lines, levels, and sizes of the intended aqueducts, indicating the various kinds of surface soil with which it is proposed to deal, and showing in detail what mode of subsoil drainage it is intended to adopt, if any, with the size, depth, and inclination of the several proposed lines of drainage, together with descriptions and particulars of the pumping power to be employed, the number of lifts, and the nature of outfall.

Also a statement showing the manner in which it is proposed to work the scheme, what kind of powers will be taken for dealing with the land to be operated upon, and how owners and occupiers are to be treated with, what quantity of sewage will be taken up daily, over what quantity of land it will be distributed, what depth it will occupy over that area of land, and if it be intended to employ varying quantities at different seasons, what the variation will be.

Also a full statement of the means of deodoriation, if any, the chemical agents employed, and the details of their mode of application, and what arrangements, if any, it is proposed to make for dealing with the heavy deposit.

Also an estimate, showing separately the cost of the engines and pumps, if any, the conducting pipe or sewer, the distributing and deodorising apparatus, and the subsoil drainage, together with the annual working expenses of each of these three heads of expenditure.

I am, &c.
(signed) *John Pollard*,
Clerk of the Board.

Thomas Ellis, Esq.,
11A, Hart-street, Bloomsbury.

Before proceeding to furnish the information required, I would wish to be permitted to take a brief review of the entire question of the utilisation of the London sewage, as I think, by so doing, I shall best be able to show how it has been that around this subject, which is in itself so simple, the darkest obscurity has been thrown, until at last a large portion of the public has been led to believe it to be an "engineering and commercial impossibility to utilise the sewage of the metropolis in a liquid state," than which nothing can be more erroneous.

About the year 1846 the Metropolitan Sewage Manure Company commenced its operations at Fulham, and as Mr. Austin, in his reports, states, "Considerable works of the most expensive kind were constructed for distributing liquid, very nearly worthless as manure, over a district, obtaining the valuable stable manure of the metropolis at the most economical rate, by means of the return carts which convey to London the produce of the market gardens, and which would otherwise return empty. In fact, practically, this was little more than a company for supplying the market gardens at Fulham with water during periods of drought; and although no doubt a beneficial service, it will readily be imagined that the saving of labour of hand-watering, over a limited district of garden ground, would produce no adequate return for so costly an establishment."—Austin's Report, Appendix No. 3.

From this it would be seen that this company calling itself a "Sewage Manure Company," which commenced operations with the loudest flourish of trumpets, which was to drain the metropolis and utilise the sewage, showed its judgment and capacity for grappling with this great question, by commencing its operations on land already all but poisoned with manure, and even then did not furnish manure to its customers, but only dirty water, which was pumped from Counter's Creek, and, as a necessary consequence of such extraordinary want of judgment, this company was a complete and absolute failure.

The entire non-success of this unfortunate company was a great fact patent to all; but the reasons of its failure were not so generally known, even at the time, still less so at the present, in consequence of which an opinion began to be entertained by the public in a confused sort of way, that it was an impossibility to utilise the sewage in a liquid state, and principally on the ground that the agricultural public would not take the sewage from a company. But I may, I think, be asked, "What was there in common between this dirty water and sewage? What in common between this defunct company and the one which I promote."

I shall, I think, sir, have no difficulty in setting the public right upon these points.

The next difficulty thrown in the way of the correct solution of this question, was a report made in the year 1853, to the Metropolitan Commissioners of Sewers, by Mr. Thomas Wicksteed, C. E., which "Report" will be found in full in the Appendix to this letter, marked No. 4. I have extracted it from "Return Metropolitan Drainage, ordered by the House of Commons to be printed, 11th April 1854, No. 180."

This "Report" has derived great weight with the public, from the fact of its having been so printed by order of the House of Commons, and by its being generally understood, whether erroneously or not I cannot say, that it was considered by the Metropolitan Commissioners of Sewers to have been quite conclusive, and to have proved beyond all question that it was a "commercial and engineering impossibility to utilise the sewage of the metropolis in a liquid state."

If such was the conclusion arrived at by the Metropolitan Commissioner of Sewers, I must beg leave to differ from them. That "Report," I maintain, proved nothing of the kind. But as that "Report" has done an incalculable amount of mischief, it is imperatively necessary that I, or any other gentleman who may hereafter press upon the Metropolitan Board of Works the adoption of the liquid scheme, should be prepared to prove that Mr. Wicksteed is entirely in error.

It would be impossible, sir, in the space of a letter in which a variety of other matter must be treated of to examine Mr. Wicksteed's celebrated "Report" with that minuteness which is desirable and may hereafter be necessary for the enlightening of the public. I shall, therefore, sir, on the present occasion, only call your attention briefly to some few of its more prominent engineering mistakes and distortions of fact, any one of which would deprive this "Report" of all weight. But admitting for the moment, for the sake of argument, that Mr. Wicksteed is quite correct in his engineering, and in his reasoning in support of that engineering, and that upon the case as stated by him he is right in saying that it is a "commercial and engineering impossibility to utilise the sewage of the Metropolis in a liquid state," what follows from that admission? Is the question settled in Mr. Wicksteed's favour?

On the contrary, as I shall presently show, he has not by his "Report" touched in the slightest degree that great question in the correct solution of which the over-taxed ratepayers of the metropolis have so vital an interest.

Referring to his "Report," we find that having previously stated the difficulty in applying the sewage water of towns in a liquid state so as to produce a commercial benefit not to have been overcome, and from the additional experience he has obtained, he is led to adhere to his former opinion, that the "difficulties are insuperable," he adds that it may be as well to consider the principles which necessarily limit the application of the system. He says, "and, for the purpose of elucidation, I will suppose the case of a town but very moderately supplied with water, in which the sewage is comparatively strong, but in which the supply of water afterwards becomes abundant, so that there shall be four times the quantity of water pressing through the sewers, and thus diluting their contents four times.

"I will also suppose that a system of mains and services had been laid over a large tract of land in the neighbourhood, for the purpose of conveying and distributing the sewage water of the town before the accession of this additional supply of water, that an engine of 100-horse power had been erected for raising and distributing the sewage, and that one-tenth of this power had been required to raise the water from the bottom of the sewers to a height of 10 feet above the level of the neighbouring river, and that the remaining nine-tenths, or 90 horse-power, had been required partly from overcoming the friction created by the passage of the water through the system of pipage, and partly to provide for sufficient pressure to distribute the water in jets over the land.

"That the cost for distributing the comparatively strong sewage water, upon this system, had been such that the revenue derived from the sale of the sewage water had so far exceeded the working expenses as to make it a profitable undertaking.

"Now, as the improved supply of water would gradually increase the quantity of the sewage water to double, treble, or four times the original quantity, the capacity of the mains and works must also be increased, either by adding to the number of engines and mains in proportion to the increased quantity of water, or, if the pipes are not increased in number or size, the steam power must be increased, first, to lift the increased quantity (and in this instance the increase of power will be in direct proportion to the increase of quantity, or from 10 to 20, 30 to 40 horse-power); and secondly, to overcome the increased friction caused by the larger quantity of water passing through the same pipes; but for this purpose it is a well-known fact, open to proof in any waterworks in the kingdom, that the power required for this purpose must be increased, not in direct proportion to the quantity, as in the first instance, but in the proportion of the squares of the quantity, or, which is the same thing, as the square of the velocity. The power, therefore, in the second instance, would have to be increased from 90 to 360 or 810, or to 1,440 horse-power, which latter would be for four times the required quantity instead of from 10 to 20, 30, and 40 horse-power required for merely raising the water a given height without distributing it; and, in my opinion, this principle has been too frequently overlooked, although it may, in fact, limit the application of the system.

"But this increase of water involves also a commercial disadvantage, for its value would be reduced in inverse proportion to the cost of distribution, or, in other words, while the capital and annual expenses might have to be increased four times only the revenue would be reduced to one fourth, every ton of the increased quantity of sewer water containing only one-fourth of the fertilising matter it originally contained."

This supposed case, if it mean anything, is intended to be a case in point, as regards the question of utilising the sewage of the metropolis. Upon it Mr. Wicksteed takes his stand, when he asserts that it is a "commercial and engineering impossibility" to utilise the sewage in a liquid state. But if his case in point, the foundation upon which he raises his argument, fail him, then what becomes of his argument?

Let us, sir, examine his case in point. And first, is London in the lamentable state supposed for want of water? Are we likely to see the water supply doubled, trebled, or quadrupled, without seeing at the same time an increase of population bearing some proportion to the future increase of the water supply, thus maintaining the present manurial value of the sewage?

Why, Mr. Wicksteed himself, in a previous part of his "Report," contradicts his own assumption, for he gives the sewage of the metropolis and New York, as instances of poor sewage, owing to the copious water supply in both those places. But, weak and incorrect as this assumption is, what are we to say to the extraordinary conclusion which he seeks to draw from it, in support of his argument against the liquid scheme, to the effect that if the sewage used by the supposed company was increased in bulk to four times its original volume, by the additional water supply, "the revenue of the company would be reduced to one fourth its former amount, every ton of the increased quantity of sewage water containing only one-fourth of the fertilising matter it originally contained?" Is it possible, sir, to conceive a statement more incorrect, or more palpably absurd?

Is it not evident to the meanest capacity, that if we take a ton of sewage, worth, let us say, 2 *d.*, as manure, and swell it out to four times its original bulk, by the admixture of pure water, admitting, for the sake of argument, that which, however, would be incorrect, that there was no manurial value in the pure water, each ton of this diluted sewage would be worth one halfpenny as manure, but the four tons would still be worth the original 2 *d.*, the value of the undiluted ton of sewage. It follows, therefore, that this supposed dilution of the sewage would in no way "reduce the revenue" of the Company, although it would of course increase the amount of the working expenses.

I wish, too, especially to direct your attention to Mr. Wicksteed's plan, as shown in this supposed case for raising and distributing the sewage, which, I may here remark, is the only plan in any way referred to by him in his "Report," for performing those operations.

He proposes to raise and distribute it by the direct action of his engine.

There are, sir, two methods by which we may utilise in a liquid state the sewage of a town, lying as London does, at a lower level than the land upon which we wish to place the sewage, and both these methods we see in operation all around, carried out by the various waterworks. And here let me remark, that if proper care be taken, we can drive sewage through pipes just as easily as we can drive water.

By the one plan pipes are laid over the districts to be supplied, and the sewage is forced through the entire system of piping, and delivered on to the land by the direct action of the engines. By the other, the sewage is pumped by the engines into a reservoir placed on an elevation, from which

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which it flows through the entire system of piping, and is delivered on to the land by its own gravity.

By the one, the engine has to lift the sewage, to overcome the friction through the entire system of piping, and to drive the dead weight, as well as to support upon the pump a large proportion of the sewage already lifted, and in addition, must deliver it on to the land with a jet.

By the other, the engine has only to lift the sewage into the reservoir, and to overcome the friction through the comparatively short length of pipe from the pumping station to the reservoir. From this last point the sewage itself becomes the motive power. It will, therefore, be easily understood that if these two systems were carried out over the said area, the work to be done by the steam-engine, in the one case, would greatly exceed the work to be done in the other. And this extra work required of the engines it is which sets a limit to the area over which we can profitably distribute sewage by the one method. But by the other method, provided we have only a sufficient elevation to which to pump the sewage in the first instance, there is no limit to the extent of the area to which it may be profitably applied, for water or sewage thus treated must of necessity find its own level, and will, therefore, flow through pipes from the reservoir placed on the heights, over all land of lower elevation.

Mr. Wicksteed, as appears from the calculations given in his supposed case, upon which, as I have before had the honour to remark, he rests his entire argument, is quite alive to the work to be done by the engine in the first of these cases, which he very justly states "sets a limit to the application of the system." But why is it, I would ask, that he preserves so absolute a silence as to the other method.

Mr. Wicksteed has been, I am informed, engineer to more than one waterworks; he could therefore scarcely be ignorant of a method which to every schoolboy must, I think, be known. Mr. Wicksteed, be it always recollected, was, as it appears from his own "Report," consulted professionally by the Metropolitan Commissioners of Sewers, and was therefore clearly bound, to the best of his ability, to place the whole case before them. Why does he discuss at such great length that plan which he states to be impossible, and why is he so silent about the other as to which there is no difficulty at all, as has been shown?

Is his silence on this point the result of ignorance, or is it caused by a desire to mislead the Commissioners, and through them the public, into the belief that it was an "engineering and commercial impossibility to utilise the sewage of the metropolis in a liquid state," and thus prepare the way for the adoption by the Commissioners of his patented plan for extracting the manure from the sewage by the lime process, which has since been proved to be an utter failure, but which in the second part of this ever-memorable "Report" Mr. Wicksteed so presses upon their notice.

But, sir, let the cause of his silence have been what it may, that silence, to say the least, deprives his "Report" of the slightest value; and I think, it will be admitted, that I was correct when I asserted, what I now repeat, that admitting, for the sake of argument, Mr. Wicksteed to be quite correct in his engineering and in his reasoning, in support of that engineering, and that upon the case, as stated by him, he is right in saying that it is a commercial and "engineering impossibility to utilise the sewage of the metropolis in a liquid state," still his "Report" in no way touches the true question of issue.

But, sir, I cannot admit that his engineering is correct, or that we can place the slightest reliance upon any portion of his "Report," so far as it relates to the utilisation of the sewage in a liquid state. In proof of which I must beg leave to direct your attention to one or two of the engineering mistakes appearing upon the face of it, any one of which occurring in his "Report" should of necessity deprive it of all weight.

Let us examine his plan for laying the pipes through which he is to distribute the sewage over his area, and it will be admitted that this is a most important point, when we consider that the object of such a company is to be, at least, able to irrigate the entire area over which their pipes are laid. It follows, then, that an engineer who gives a plan for the laying of the pipes, which cannot by any possibility effect the object in view, is, to say the least of it, unequal to his task.

How, then, does Mr. Wicksteed proceed? As well as I can gather from his exceedingly obscure and confused "Report," his plan is to lay 12 38-inch radial pipes from the point of supply, extending over the entire district to be irrigated; he then divides this circle into eight spaces, inclosed by seven concentric circles of mains, averaging 12 inches diameter, connecting the 12 radial pipes. Now, if we make a drawing of this plan, we will find that we have got before us something very like a cart wheel of a superior description, the seven concentric circles of which would add greatly to the strength and solidity of the 12 radial pipes or spokes of the wheel. But however much we may admire this as a wheel, we cannot for a moment admit that by it Mr. Wicksteed can wheel the sewage on to the various farms upon his area.

Sewage must be conducted over the area just as water is supplied to a town. Imagine, sir, these radial and concentric pipes being laid in a town which required to be supplied with water, cutting in all directions through the houses, going through the centre of one, cutting the corner of another, and leaving a great majority of the houses without any supply at all: what would be said to an engineer who would venture to advocate Mr. Wicksteed's cartwheel theory, as the proper one to be adopted in such a case? why, sir, he would be scouted as an ignorant pretender, or as an arrant blockhead; and as Mr. Wicksteed's plan would operate on the farms upon his area precisely as it would do upon the houses in a town, it must, I think, be set aside as entirely inadequate to the object in view; that object can, however, sir, be very easily obtained by conducting the supply pipes along the roads, just as we conduct the pipes of a water company along the streets of a town, for as all the houses of a town can be reached from the streets, so all the farms on the area can be reached from the roads, as every one knows, who is at all familiar with agricultural affairs.

There is another very glaring engineering mistake in this gentleman's "Report," to which I would wish to direct your attention, and that is, his escape for the sewage.

A sewage company, proposing to dispose of all the sewage of the metropolis by irrigation, differs from a water company in this point, that inasmuch as when the water company has pumped a sufficient supply for the day, it can stop its engines, and the stream from whence it has derived its water will flow on upon its course without in any way interfering with or injuring the machinery of the company.

Not so with the sewage company; it has by its machinery to dispose of, in some way, the entire mass of the sewage. How is this to be done?

Let us suppose any one of the following cases:

1st. That from any cause the demand for the sewage, if for the time less than the supply.

2d. That the pipes burst or require repairing.

3d. That the engines themselves get out of repair, and that we thus lose the power of putting any portion of the sewage upon the land.

What, in any of the above cases, are we to do with the sewage which cannot, at the moment, be put upon the land?

Are we to store it away in reservoirs until we may require it?

If so, what are to be the sizes of those reservoirs, and where are they to be placed?

Are we to construct reservoirs sufficient to contain a day's supply, or a week's, or a month's, or six months'?

The cost of constructing reservoirs sufficiently large to contain even twelve hours' supply must convince us that storing the surplus sewage in this manner would be a commercial impossibility. In addition to which it may be observed that were we to adopt this plan, we must necessarily greatly increase the number and power of our engines, thus adding to our outlay, for, in addition to the regular work they would have to perform, they would occasionally have to dispose of this arrear (if I may so call it) of the sewage. No, sir, the plan of reserve tanks is an engineering mistake.

How then are we to secure a safe and economical escape for the sewage, which escape is as absolutely necessary as is the safety-valve of the steam-engine? Such an escape, to answer every purpose of safety and economy, should be in the rear of all our works, and perfectly independent of them, an escape which, if all the works and the machinery of the company were at one blow annihilated, would still remain to preserve the public from annoyance or from injury. Such is the escape which we must have, and such is the escape which your talented engineer has devised in connection with your main drainage scheme.

But what is Mr. Wicksteed's escape? Again, I must grope my way through the dark and involved obscurity of his "Report," and I find it referred to quite incidentally thus:—"Taking the cost of distributing pipes and tanks for holding the liquid sewage when it cannot be applied at 3 *l.* per acre, 1,111,460 acres at 3 *l.*, 3,334,380 *l.*

But this does not tell us where these tanks are to be placed. Again, therefore, I must grope my way for his meaning, and in quite another part of his "Report" I find these tanks again referred to, and placed thus:—

"A detailed calculation will be given in the Appendix, but the foregoing will perhaps be sufficient to convince the Commissioners that the liquid scheme, even if it could be carried out as herein proposed, is not a feasible one; but when, in addition to what has been stated, it is borne in mind that the basis upon which the calculation rests is upon the assumption, first, that the whole of the sewage water could be collected in one central spot; secondly, that 12 38-inch radial pipes could be laid in straight lines from the central point; thirdly, that the circle of 66½ miles in diameter round the metropolis is a flat plain, and that the Surrey hills on the south, and the Middlesex and Hertfordshire hills on the north, do not exist; fourthly, that a sufficient number of landed proprietors could be found within the proposed extent of district to use so large a quantity of one kind of manure, and as the supply must be constant to construct covered reservoirs on their lands to hold the supply during such periods as it is not being actually poured upon the land, and unless these, to me impossible, conditions can be complied with, the estimate for 12,000,000 *l.* will be found much too small. I think the Commissioners will agree with me, that such a scheme for the disposal of the sewage water of the metropolis should not be entertained.

Here again, sir, we see these tanks referred to, and for a precisely similar purpose, "to hold the sewage during the periods it is not being actually poured upon the land." We might, therefore, naturally come to the conclusion that they are the same tanks, and that they are to be placed on the farms that are to be irrigated, and such I really believe is his meaning. But his "Report" is so involved and so obscure that not only is it extremely difficult for those not in the secret to discover what he really means, but sometimes, as in the present instance, putting the best construction upon this apparent confusion, it would appear he does not himself know, for, in the item where these tanks are first named, he charges the costs of their construction against the Company, and in the second he charges them against the owners of the land; but in both cases it will be seen how nicely the manner of charging suits the argument at the moment. In the first case it is used to crush the Company, as an enormous item of expenditure over 3,000,000 *l.* In the second it is stated as a necessary outlay upon the part of the landowners before they can use the sewage, and therefore likely to deter them from taking it.

But in these tanks, let them be constructed by whom they may, we find Mr. Wicksteed's sole escape for his sewage. Of what size are they to be constructed? Are they to contain a week's, two weeks', a month's, or six months' supply?

Suppose, sir, for the sake of argument, we fix on any one of these periods, and that accommodation is required for but one day's or one hour's supply more than provision has been made for, what becomes then of Mr. Wicksteed's plan?

Or, suppose that his engines break down, and that he cannot pump his sewage into his "reserve tanks," what then becomes of his plan?

But are these "reserve tanks," which are to contain his sewage during those periods that it is not being poured upon the land; are they, in reality, "reserve tanks" at all, or simply enlargements of his sewage mains, and, therefore, of no use under any possible circumstances as "reserves"?

Let us examine them. They are to be covered, and one at least is to be placed on each farm, connected, I presume, with the supply-pipe, although Mr. Wicksteed does not say so. Let us suppose that the mains have been laid down over the entire area, the "reserve tanks" constructed, and everything in working order, and let us commence operations for the first time, when, of course, the pipes and "reserve tanks" will all be perfectly empty, what result shall we see?

Will not the sewage of necessity fill all the pipes and "reserve tanks," first filling those on the

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the low levels before reaching those upon the higher levels, those on the low levels being always under so great a pressure as will ensure their bursting, if not constructed of enormous strength? This dangerous amount of pressure may of course be guarded against by placing ball-taps within those "reserve tanks," as is done in the water-cisterns within our houses. These ball-taps will cut off the supply so soon as the "reserve tanks" are filled; but, with the supply, we also cut off the pressure. How then, in this case, could we deliver the sewage on the land? This objection may be met by saying, that the tanks are to be placed, in each case, on ground sufficiently elevated to command the rest of the farm; but that is assuming that such ground can be found on each farm, which is certainly not the fact.

Thus we see, sir, that Mr. Wicksteed has no escape whatever for his sewage, which escape is, as has been shown, an absolute necessity if we are to utilise the sewage in a liquid state, and that his "reserve tanks" are engineering mistakes.

The estimate of the cost of works which he states to be necessary is, in the most extraordinary manner, run up to 12,000,000*l*. This estimate, I shall at any time be prepared to show, is as absurdly strained and incorrect as is his engineering; but on the present occasion I shall, sir, merely ask you to refer to his estimate, when it will be seen that even on that estimate he cannot avoid showing a return of 10 per cent., selling his sewage at 1·72*d*. per ton, although the annual bulk of his sewage is only 166,719,190 tons, or nearly 100,000,000 less than I provide for by my estimate.

In the above brief and hurried remarks upon this gentleman's "Report," I think I have succeeded in proving that his engineering, as shown in that "Report," is utterly incorrect, and that his opinion, founded upon that engineering, and so loudly reiterated against the possibility of utilising the sewage of the metropolis in the liquid state, is just as much to be depended on and as valuable as is his engineering. Yet, sir, this is the "Report" which, since 1853, has set bounds to inquiry, so great is the terror of Mr. Wicksteed's name as a hydraulic engineer, which, since that year has, if I may say so, arrested the intellect of England, and made it an impossibility to establish any company to utilise on a large scale the sewage of our cities and large towns in that form in which alone it ever can be profitably dealt with. In this "Report" we find embalmed all those trivial and absurd objections against the liquid scheme which appear to be stereotyped on the minds of a large proportion of the public, who, without examination, have adopted the doctrines of this man. In this "Report," too, we find also those sneers against the engineering ability and the honesty of all professional men who may dare to differ from his opinion, which appearing upon the face of such a document, are so supremely ridiculous.

The failure of the Metropolitan Sewage Manure Company, coupled with Mr. Wicksteed's celebrated "Report," are, as it appears to me, the sole foundations for that opinion hostile to the utilisation of the sewage of the metropolis in a liquid state which is entertained by many; but that the question at issue has not been in the slightest degree touched by either, has, I think, sir, been shown by me.

These two events, however, have been eagerly laid hold of by numerous chemists and an army of quacks, who seek by every means to thrust upon the public their deodorising nostrums. These are they who lament the failure of the Metropolitan "Sewage Manure" Company, a failure which, according to them, must attend any future company attempting to utilise the sewage in a liquid state. These are they who hold up continually for our admiration that great hydraulic engineer, Mr. Wicksteed, before whom we are to bow down low in silent adoration. These are they who to promote their selfish ends, or from utter ignorance of the subject, ceaselessly slander the sewage.

These deodorisers feel, and justly, that their services are not likely to be applied for, unless they can induce the public to believe that the sewage cannot be dealt with as a manure without their intervention; hence their unanimous support of Mr. Wicksteed's engineering, and their outcry against sewage irrigation without deodorisation, as a stinking nuisance prejudicial to the health of the public.

We have already seen what value should be attached to Mr. Wicksteed's engineering, and that, therefore, upon that ground, the deodorisers cannot maintain their position, let us see if they are more fortunate in the selection of the second.

To maintain their position they must prove that the flowing sewage of the metropolis is a stinking and dangerous nuisance, if put on the land without deodorisation. Upon them lies the onus of the proof.

"What," they will properly exclaim, "what! deny that sewage stinks? Do not we all smell it in hot weather? Were we not all but poisoned in the metropolis during the late hot summers by the frightful smell caused by the sewage in the Thames"?

They cannot, however, close the discussion in their own favour by these questions. They must first prove that the offensive smell which we all perceived, came from the flowing sewage, and, if from it, then that the newly-arrived sewage was in fault, and not that old, stale sewage, which as proved by the float experiments, must have been floating backwards and forwards for years between the bridges.

But can they even prove that the nuisance proceeded from the old sewage, or any portion of it, so long as it remained floating and in motion?

On this point let us have, as we fortunately can, the evidence of witnesses of character and standing, who have no interest to serve one way or the other.

Permit me, sir, to refer you to the "Report on the Deodorisation of Sewage, by Dr. Hoffman, F.R.S., and Dr. Frankland, F.R.S., pursuant to the Order of the Board of Works, 27 May 1859." At p. 6, those gentlemen say, "During the performance of these experiments, which, as already stated, were made during the hottest portion of a dry summer, we were surprised to find that the liquid flowing from the outfall of the sewer was by no means strongly offensive; it was only after preservation in tanks for 24 hours or upwards that a really powerful odour presented itself."

These operations with the sewage, as you will perceive, sir, by a reference to the same Report, were carried on in an open tank placed on the river-side, at the outfall of one of the sewers, and fully exposed to the entire action of the sun. Could the sewage be exposed to a severer test than to be kept thus in a tank exposed to a burning sun, and perfectly stagnant? Yet not till 24 hours was it that a really powerful odour manifested itself.

If this statement by those gentlemen be correct, am I still to be told that there exists a necessity for the sewage to be deodorised before applying it to the land? Are we to deodorise that which is not offensive?

Under scarcely any circumstances is the flowing sewage, as it leaves the outfall of the sewers, as offensive as guano, and, under no circumstances, is it as offensive as good farm yard dung. Now, who will venture to require that guano or farm-yard dung should be deodorised before being applied to the land? If, then, we are not required to deodorise these manures, why should we be required to deodorise a manure still less offensive, and which, from its being a liquid manure, is more completely and more rapidly deprived of all smell when applied to the land in moderation, than any other; the earth being, as we all know, the most perfect deodoriser in the world.

Therefore, far within half that portion of time mentioned by these gentlemen, before the expiration of which, even under the most adverse conditions, the smell does not become offensive, the sewage must, of necessity, if applied to the land in moderation, be not only entirely absorbed, but effectually prevented from becoming offensive.

Having thus briefly shown that there is not much foundation, if any, for the opinion which some parties entertain, that it is a "commercial and engineering impossibility to utilise the sewage of the metropolis in a liquid state," or that, if so utilised, it must of necessity be "deodorised" before being applied to the land, I will not, I feel, be considered unreasonable by you, sir, if I claim from the Metropolitan Board of Works their prompt and dispassionate examination of the proposition with reference to the utilisation of the sewage of the metropolis, which I have done myself the honour to make to them, a proposition in the acceptance of which by the Metropolitan Board of Works the ratepayers are interested to the extent of over 700,000 *l.* a-year, and the agricultural population upon the area I propose to irrigate to a still greater amount.

But, before proceeding to give the particulars of my proposition, or my plan and estimate in support of it, I would wish, sir, to be permitted to draw your attention to two methods in which the sewage of the metropolis may be utilised in the liquid state:

The one method, certain to secure for itself the active opposition of every agriculturist and of every thinking man:

The other as certain to secure the support of the nation.

By the one method the sewage of the metropolis might be utilised upon the private estate of a company, who would themselves be the consumers; by the other, the sewage would be simply conveyed by the company into the country, and retailed to the farmers upon the area to be irrigated.

By the one method, the advantages to be derived from the operations of the company would be confined to the fewest number; by the other, it would be extended over the greatest number.

Those who would advocate the first method, would point probably to the results obtained at Edinburgh by pouring vast quantities of sewage over a limited area. There, as will be seen in Appendix, No. 3, as much as 8,490 tons are applied per acre.

This land to which the sewage is applied was formerly a barren shingle; now the land is let at 40*l.* per acre per annum for meadow. This is loudly proclaimed as an astounding success. I, however, maintain that it is nothing of the kind, but that, on the contrary, it is an immense commercial failure, and a disgrace to Edinburgh.

Let us test this "great success" by a very simple calculation. Edinburgh, as we all know, is not so well supplied with water as is the metropolis, consequently the sewage of Edinburgh must be the stronger of the two, and therefore the more valuable as manure. But, admitting for a moment, that which, however, would be incorrect, that the sewage of Edinburgh is only worth 2 *d.* per ton (that being the value of the London sewage), we find that the quantity of sewage placed upon each acre (8,490 tons), at 2 *d.* per ton, is worth 70 *l.* 15 *s.*, and as the land is then let at 40 *l.* per acre per annum, there is a clear loss of 30 *l.* 15 *s.* per acre, without making any allowance for cost of management, rent of land, or other charges.

I have no doubt that these meadows are a very good speculation for the proprietors, but the lavish expenditure of the sewage tells its own tale as to the price paid for it, and the profits therefrom to the ratepayers.

Now, as the sewage of the metropolis is the property of the ratepayers, and to be utilised for their especial advantage, it is not at all probable that the Metropolitan Board of Works, as the representative of the ratepayers, would, under any circumstances, tolerate a repetition of the Edinburgh scandal.

But, supposing, for the sake of argument, that from some extraordinary conjunction of circumstances the Metropolitan Board of Works did make over the sewage to such a company:

What would be the result? What would be the prospects of success of such a company?

Let us, sir, first ascertain what would be the cost of the necessary works for the utilisation of the sewage by that company.

In Appendix, No. 3, will be found an extract from the "Report relating to the Main Drainage of the Metropolis, 1857, Sess. 2."

From this we learn what would be the cost it would be necessary to incur for the daily distribution of the ordinary daily flow of the metropolitan sewage over 100,000 acres of land (that being the quantity required for its consumption) laid down as water meadows, and we find that, without making any allowance for the purchase of the land, the cost of the works alone would amount to 7,406,500 *l.*

Now, sir, supposing the capital raised, which I think I shall be able to show presently would be an impossibility, that the company had got their Act of Parliament, which, however, they never would get, and supposing that their works were completed, what would be the result of the speculation to the shareholders and to the outside public?

I think it is fair to assume that the farm would be cultivated only as meadow, which would probably be let each year in lots by auction. Any other system, for various reasons not necessary here to be stated, would be a perfect impossibility over so large an extent of land.

Judging from the results obtained on the barren shingle at Edinburgh, I think we may fairly assume that the weight of meadow which would be raised on even ordinary land by this system would be very great indeed; and, upon one acre thus treated, as much meadow would be grown as on ten acres of ordinary land under the old system.

By this calculation we find that we would have upon the company's farm of 100,000 acres, as much grass as could be grown on 1,000,000 acres under ordinary cultivation.

What, sir, would be the result to the outside public by this company throwing upon the market such an enormous quantity of meadow? Where would they get customers? And what would be the price they would obtain for the commodity?

These are questions which I think any man of common intelligence would ask himself before he put his money into the speculation.

It will not do to point to Edinburgh, and say the meadow lets there for 40*l.* per acre. This is not a case in point, as there are only 260 acres so treated at Edinburgh, and the produce from so limited an area would not be felt on the market; not so with the produce from 100,000 acres.

Would Parliament take a favourable view of a gigantic company of this sort entering into competition with the mass of small farmers and deranging the course of trade?

But, supposing the company had its capital raised, how is it to get possession of the land on which it is to carry on its operations? I shall probably be told by its supporters that Parliament will give to this company the same power of compulsory purchase as to a company proposing, say, to make a railway. But this is an error. Parliament invariably refuses to give such powers to a private company for a private object, such as this would be. And this very point was again decided no later than last Session, when a company, proposing to erect a large hotel in the Strand, upon the site of Holywell-street, was refused those very powers, as "unconstitutional," although this company, by sweeping away that sink of iniquity (Holywell-street), would have conferred a great boon upon society?

And finally, sir, would it be possible for such a company to raise the necessary capital?

This would entirely depend upon the persons who would place themselves at the head of the movement, and who would identify their names with the company. Would we find at its head the great landed proprietors of England, acting in the interest of agriculture and the general public, whose very names would arrest for the enterprise the attention of the nation; or, simply, stock-jobbing speculators, whose only inducement was their own personal gain, and whose names would carry no weight with the public?

We can, I think, sir, have no difficulty in arriving at a just conclusion upon this point.

The great want experienced by agriculture in this country is caused by a deficiency of manure. To supply this want we send to all parts of the world. That want places agriculture in this country "at the mercy of those who may any day become our active enemies." What does Liebig say upon this very point in his Modern Agriculture, page 269:—

"In the actual position of English agriculture, America, by her guano beds, rules the prices of all the corn markets of Europe, and more especially of England; and, should circumstances ever occur to prevent the importation of guano into England, a state of things would arise in that country of which the consequences might be incalculable; bloody wars have sometimes sprung from causes of much less importance." And, again, in the same work, he says:—"From the enormous increase in the population of London and other large cities in Great Britain, the loss which the English fields sustain annually in the main condition of their fertility is every year becoming more and more considerable."

Can it be supposed, then, that in the face of such a state of things, that the intelligent agricultural interest in this country will stultify itself by assisting in any way the formation of a company that must be the greatest enemy to that interest in monopolising, for its own enrichment, that manure which it is for the true interests of agriculture to see distributed over the largest area, and among the greatest number of farmers.

These are some of the reasons, sir, which lead me to the conclusion that such a company never would receive that support from the agricultural interest or the public, which is so absolutely necessary for the successful solution of this great question, and never would be tolerated by Parliament.

It follows then, sir, I think, that the Metropolitan Board of Works, acting in the interests of their constituents, the ratepayers, as well as in the interest of the general public, can deal only with a company such as I promote; one which will be a mere carrier and retailer of the sewage.

My plan is as follows:—

I propose to take the sewage from the outfall tanks which are to be constructed in connection with the great main drainage scheme of the Metropolitan Board of Works.

I allow the sewage to flow from those tanks through covered aqueducts, in the bottom of which numerous pits will be constructed and fine gratings erected across them, to catch all heavy or floating matter likely to be injurious to the engines; and, I may here remark, that these aqueducts, as well as other vital portions of my plan, are to be constructed in duplicate, for reasons which will readily be understood.

Through these aqueducts the sewage will flow to my pumping stations, and from thence will be pumped by Cornish steam engines through covered mains up to covered and well-ventilated reservoirs, which will be placed on heights of sufficient elevation to command the area to be irrigated, and which reservoirs will be so constructed as to prevent all escape of noxious gases.

From these reservoirs it will flow by gravitation into the agricultural districts, through covered pipes laid under the roads.

By this plan I place myself precisely in the same position as a gas or water company proposing to supply a town with gas or water. Such a company, by laying down their mains through the streets of the town, puts it in the power of every householder to become a customer of the company, should he so desire. If he determine to become a customer the householder lays down, at his own expense, any piping he may require for his own purposes within his house. So, in my case, by laying down my mains along the roads, I put it into the power of every farmer within the area to deal with me; and any farmer electing to become my customer will lay down, at his own expense, whatever piping he may require for his own purposes within the bounds of his own farm. His pipes on his farm will be connected with my mains; and placed at the junction between the two will be a water meter, which will register the quantity of sewage taken upon the farm.

According to the size of the farm, one or more hydrants will be erected on the land, from which the sewage will be distributed by the farmer through flexible hoses. The sewage in the company's mains being always under pressure it will be delivered with a jet, and fall on the land like rain.

The piping on the farm, if permanently laid, will cost the landlord or occupier, as may be arranged between them, about 3 *l.* 15 *s.* per acre for iron pipes and hydrants complete; if, in bitumerised paper pipes, something less than half that amount; or, if moveable surface pipes of bitumerised paper are used, the cost will average 10 *s.* per acre, as the same pipes can be moved from field to field as required.

Perhaps I shall be told that the agriculturists will not go to this expense; to which I reply, they certainly will not, unless they see that it is for their interest so to do. But if, as can be seen in every case where sewage has been already utilized, the value of the land has, to say the least, been more than doubled, I think the company will not have much to fear on this point.

Referring to Mr. Pollard's letter, I may here remark that I do not propose to interfere in any way with the cultivation or the management of the lands occupied by my customers. Holding simply the position of a manure merchant, I require no special powers; selling to them at my own price, as much manure as they may require, which they will themselves apply to their lands at all seasons of the year, and at any period of the day or night that may suit their convenience or their necessities. The extent of my area is so large that the greatest average quantity of sewage per acre that can be applied is 500 tons, or 4·9 inches in depth; and as that amount is certain never to be applied at one dressing, but rather in several, the amount used on each occasion will be no more apparent on the land than would a slight shower of rain.

My "outfall" for the sewage will thus be on the lands to be irrigated. The escape for the sewage, in cases of accident to the machinery, &c., &c., would be into the Thames in rear of all my works, and perfectly independent of them.

I have mentioned that I propose to pump the sewage into covered reservoirs; these reservoirs will be placed on Hampstead and Shooter's Hills, or such other high lands as may be approved of by the Metropolitan Board of Works; from these two commanding points, I can irrigate on either side of the river a much greater area than would be required for the metropolitan sewage.

It will be evident to all that for the successful working of my plan provision must be made to hold the sewage during those hours of the day or night in which it is not being put upon the land. That provision, it will be found, is made for the sewage by my tanks and wells, as well as by the system of pipes over the area; and the hours of the night will be to me an acceptable and valuable aid to enable me to keep the entire system charged, and in full working order.

The reservoirs on Hampstead and Shooter's Hills will perform another, and a very essential service. By their aid I can regulate at all times, with the utmost nicety, the quantity of sewage it will be safe to pump, as by the assistance of a gauge placed in the engine-house and connected with the reservoirs, we can tell the exact quantity of sewage in the reservoirs. When the sewage rises beyond a certain height in them, as shown by the gauge in the engine-house, I shall cease pumping until it falls again, allowing the sewage in the meanwhile to remain in the tanks of the Board of Works, when, should the quantity at any time accumulate to a considerable amount, I shall deodorize it, should the Board of Works require me to do so, and then let it flow into the river at the proper period of the tide.

Thus it will be seen that this vast machinery, extending over an area of not less than 1,680 square miles, can, from the point of supply, be kept under the most perfect control almost by a child.

In the above plan for utilizing the sewage of the metropolis in a liquid state, I have shown "how to do it;" but Mr. Thomas Wicksteed's plan, as given in his report, shows us, on the contrary, "how not to do it," and that, if it could be done, it would not pay commercially, and in support of that assertion he gives his estimate of cost. I also give my estimate of cost, the full details of which will be found in the Appendix to this letter, marked No. 2. By this it will be seen that selling the sewage, at twopence per ton, I can pay a dividend of 30·4 *l.* per cent. upon the outlay for works, &c. But this estimate, I would wish to state, I do not look upon as correct, being greatly in excess of what the true estimate will be when the necessary surveys are taken. But it is made purposely in excess, as a reply to Mr. Thomas Wicksteed's assertion, and to prove to the Board of Works that not only is there no foundation for that assertion, but that, in addition, the utilization of the sewage of the metropolis in a liquid state must, of necessity, be one of the most brilliant commercial successes ever achieved in England.

In proof of my assertion, that my estimate is greatly in excess of the true amount, permit me, sir, to direct your attention to two of its principal items. First to the amount of engine-power, and, secondly, to the quantity of piping charged for.

The quantity of engine-power required must be determined by the amount of sewage to be pumped, and the distance and height to which we have to pump it, and at the rate at which it is to be pumped. Now, with reference to the actual amount of sewage to be dealt with, I am in some little doubt, not having access to those correct sources of information upon that subject at the disposal of the Board of Works. I find in the "Report of the Referees," that Captain Galton, J. Simpson, C.E., and Thomas Blackwell, C.E., were of opinion, "that the flow of sewerage per head of the whole population should be calculated at not less than seven cubic feet per diem." That calculation of those gentlemen is exclusive of rainfall.

By it we find, taking the population of the metropolitan area at 3,000,000, the annual bulk of the sewage would be 47,467,783,000 gallons = 7,665,000,000 cubic feet = 217,762,650 tons, requiring engines of 12,528 horse-power net, or 23,490 horse-power gross; provided we pump to the heights, and at the rate specified in my estimate. But to this sewage we must add the rainfall. Now, the average fall of rain on the metropolis is 25 inches per annum, and the area to be drained by the works at present in progress, 103 square miles. We thus find that we have an amount of rainfall to dispose of equal to 37,483,087,359 gallons = 5,972,668,416 cubic feet = 169,683,510 tons; but as a portion of this rainfall will escape in various ways, we must allow for this in our calculation, say one-third of the whole amount. Thus we will have 72,456,507,906 gallons = 11,646,778,944 cubic feet = 330,884,990 tons of the diluted sewage to be disposed of, requiring engines of 19,229 H. P. net, and 36,054 H. P. gross.

But your engineer, Mr. Bazalgette, differs in opinion from these gentlemen, and bases his

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calculation, I understand, upon 5 cubic feet per head per diem, exclusive of rainfall. By his calculations we would have of sewage per annum 34,219,845,000 gallons = 5,475,000,000 cubic feet = 155,544,750 tons, requiring engines of 8,949 H.P. net, and 16,779 H.P. gross.

But, as before, to the quantity of sewage must be added the rainfall, which would give as an annual total of 52,208,569,906 gallons = 9,456,778,944 cubic feet = 268,667,090 tons, requiring engines of 15,706 H.P. net, and 29,449 H.P. gross.

These calculations differing so much from one another, I found myself in considerable difficulty, as upon the quantity of sewage would depend not only the amount of engine-power required, but also the size of my tanks, mains, &c. I have thought it, therefore, safest to reject both of them, and base my calculations upon the outside quantity your outfall tanks are capable of containing; and I may here remark that for my present purpose it is a matter of no importance whether I have based my calculations on too great or two small a quantity of sewage, as when the true working estimate comes to be made, this error can be corrected, and the calculation increased or diminished as required, the return being increased or diminished in equal proportion to the outlay.

I find that, basing my calculations on the maximum contents of the outfall tanks of the Board of Works, there will be per annum an amount of sewage to be disposed of, equal to 58,531,537,020 gallons=9,364,746,600 cubic feet=266,052,441 tons, requiring engines of 15,556 horse-power net, and 29,167 horse-power gross, provided I pump this amount to the height stated in my estimate.

By reference to my estimate, it will be seen that I make my calculations for pumping not only to the top of Hampstead and Shooter's Hills, but about 30 feet in addition, to allow for correction for wells and tanks. Now, I by no means think it will be necessary to pump to the extreme top of either of those elevations, as a glance at the locality will show us that, without pumping to the top of either of these hills, I can irrigate a larger area than is required to absorb the metropolitan sewage.

But, as I have not yet gone to the expense of taking the levels (which expense is only one of many which are necessary, but, of course, cannot be thought of unless the Board will first grant the concession), and as I therefore do not know the exact point to which it will be necessary to pump, I have thought it more honest to make my calculations as for pumping to the very top, thus stating the case as broadly as possible against myself.

The next point in my estimate to which I wish to direct your attention, as over-charged by me against myself, as in the last case, is the item for distributing mains.

It will be seen that I allow 1,680 miles of distributing mains, or one mile on an average for each square mile of area. Now, I believe that quantity is greatly in excess of what will be found necessary. Mr. Wicksteed, for his area of 3,500 square miles, only allows 1,236 miles of mains, or one mile of main to 2·8 square miles of area. Thus it will be seen I allow within ·2 of three times the quantity of mains over my area that Mr. Wicksteed does on his, a clear proof, if one were wanting, that I must be in excess, as that gentleman cannot be charged with under-stating any item in his estimate of cost for the works necessary for utilizing the sewage of the metropolis in a liquid state.

I believe I might with perfect safety reduce this item in my estimate by half, and allow only one mile of main to two square miles of country, and even then I would be in excess of Mr. Wicksteed.

This reduction, without making any allowance for the expected reduction of the item for engines, or any other item in my estimate, would contract the necessary outlay for utilizing the sewage to 4,174,122 *l.*, allowing us a return of 53·1 *l.* per cent., which return could be scarcely looked on as a commercial failure.

But I do not think it just to my own reputation to do so, until I have satisfied myself, by actual examination, as to the exact state of the case, which can be very easily ascertained by a measurement of those roads within my proposed area under which it will be necessary to lay the pipes.

This, however, is another of the many expenses that no sensible man would incur until after a concession was agreed to by the Board of Works.

But here arises the most interesting point in the question of the utilization in the liquid state of the sewage of the metropolis or any other town; that is, the extent of area required to absorb the sewage with profit to all parties; the items for distributing mains being always the heaviest in any estimate for utilizing the sewage in the liquid state.

This is a question which I think has not been publicly solved, as far as I am aware, by any gentleman, either engineer or agriculturist, who has preceded me in this inquiry.

On referring to Mr. Wicksteed's report, I find that he bases his calculations, as to the extent of his area, upon a calculation made (as he asserts) by Mr. Smith of Deanston, "that from 80 to 160 tons of sewage water per acre per annum might be usefully applied to the land upon an average of arable and pasture, or in some instances more." And on this Mr. Thomas Wicksteed makes his average 150 tons to the acre, thus securing an immense area, and swelling out his estimate in proportion.

I am not aware when or where, or with reference to what particular state of things, Mr. Smith made his alleged calculation, if he ever did make it, but the result arrived at by that alleged calculation is as erroneous as is the engineering based upon it by Mr. Wicksteed.

The next attempt to fix the area that I can find in any publication, is in a work by a Mr. George Shepherd, entitled "London Sewerage and its application to Agriculture. The London Drainage, and how to apply the Sewerage to the Land with advantage to the Farmer and the Capitalist. The only Comprehensive Plan yet proposed for applying the Sewerage to the Land," published in 1857, by Effingham Wilson, Royal Exchange. At page 33 of that work, I find Mr. George Shepherd states:—"If we take the whole of the sewerage of London, as it goes into the Thames, at 70 millions of tons annually, or 50 millions of tons for the Middlesex side, and 20 millions of tons for the Surrey side, inclusive of the towns of Greenwich and Woolwich, and if we allow for each acre 40 tons of sewerage per annum, the Middlesex sewerage would manure 1,205,000 acres, or 1,953 $\frac{80}{640}$ square miles; the Surrey sewage would manure 500,000

500,000 acres, or 781$\frac{160}{640}$ square miles, or a total of 175,000 acres, or 2,734 square miles surface area." And at page 39 of the same work he states :—"It is proposed to give the farmer 50 tons of sewerage for 20*s.*, or 750 tons for 15*l.*, the price of one ton of guano," which would be nearly at the rate of 5*d.* per ton.

In the same work he gives the details of his scheme, the most prominent part of which is, a number of district reservoirs, for regulating the supply and distributing of his sewage; against which, the same and some other engineering objections may be urged as against Mr. Wicksteed's plan of "reserve tanks."

It should, however, in fairness to Mr. George Shepherd, be stated, that in a prospectus afterwards published by him of a company to utilize the sewage of the metropolis, although he still abides by his objectionable plan of "district reservoirs," he abandons the idea of charging 5*d.* per ton for the sewage, and proposes to "supply the farmer with sewage, *ad libitum*, at the rate of 30*s.* per acre per annum."

I do not think, sir, it would be judicious to charge an annual rent per acre for the sewage, as farmers would not like to saddle themselves with an additional rent. They would object, firstly, to paying a rent for the use of the sewage upon that portion of their lands that they did not irrigate; and if the projected company, to do away with that most proper objection, were to agree to charge the rent only for those acres on the farm actually irrigated, would not this arrangement open a vast field for fraud? for how could the company prove what fields had or had not been irrigated?

But, sir, whether we charge 5*d.* per ton for the sewage or 2*d.*, the actual value, or whether we give it to the farmers, *ad libitum*, to be in a position to give it to them at all, we must first lay down our works over the area to be irrigated; and to do so properly, we must first ascertain the average quantity of sewage per acre required on the land.

Now, Mr. Wicksteed and Mr. George Shepherd both tell us how much sewage they will allow for in their calculations, but they do not show us why the quantity stated by them is the proper one upon which to base a reliable calculation.

Is it not surprising, however, sir, that mere engineers should fail to show us this, as it is more within the province of the agriculturist to do so; and, when he has given the quantity, then the engineer can make the necessary calculations. When, therefore, I was informed that that eminent agriculturist, Mr. Mechi, had, in 1860, published a work "On the Sewage of Towns as it affects Agriculture," I felt certain that he had not overlooked this most important and, I may say, vital point. I was, therefore, most anxious to obtain a copy of that work, to ascertain if Mr. Mechi agreed with the opinion I had been led to form upon the point, from my long connection with the management of land, and no inconsiderable research.

At page 16 of his work, I find Mr. Mechi states as follows :—"Influence of sewage manure on my farm profits. I am much indebted to the sewage system on my farm in this respect. For the last six years my gain as landlord and tenant on my little farm of 170 acres has been nearly 700*l.* per annum. Even this last year, with wheat at 42*s.* per quarter, I have gained 600*l.*, after paying every expense. Of course, much of this benefit has arisen from steam power, drainage, deep cultivation, and other improvements, but the liquified manure system has greatly contributed to this result."

Here we find Mr. Mechi, in speaking of the same operations on his farm, first, as the "sewage system," and, in the second place, as "the liquified manure system." Now there is nothing in common between the two, except that both are liquid manures; but as the strength of what we understand as "liquid manure" will depend principally upon the amount of its dilution, and as it is invariably made stronger than the metropolitan sewage, nothing can well be more calculated to mislead us than to call both "liquid manure," or to suppose that, because certain results in agriculture have been obtained by the use of an ascertained amount of comparatively strong "liquid manure," therefore a like result will be obtained by the use of a similar quantity of weak sewage. Nor is Mr. Mechi, as far as I am aware, qualified to give an opinion on the value of sewage as a manure from actual experience, as all the operations on his farm are carried on with the aid of "liquid manure."

The error into which Mr. Mechi here falls does not prepare me to accept, without question, the correctness of the calculation to find the area which he gives at pages 20 and 21 in the same work. He there states: "How many acres would the London sewage fertilise? Cost of application and prospects of remuneration to a company? Before this question can be answered, we must settle whether we are to manure for a rotation of ordinary farming crops, or to produce enormous crops of Italian rye-grass pasture, root, and other green crops, for the production of meat and dairy produce.

"These green and root crops would absorb an enormous supply of sewage, probably as much as 1,000 to 3,000 tons per acre; but in preparation for the alternate mode of ordinary cropping 200 to 300 tons would be a more suitable dressing. Two thousand tons would probably be equal in value, for green crops, to one ton of guano, and at one penny per ton would cost only half its price."

To Mr. Mechi's opinion on all these points I am forced to object. First, I maintain, what I think must be admitted by all, even by Mr. Mechi when he shall have re-considered this subject, that on so vast an area as is required to absorb the sewage of the metropolis, it would be utterly impossible to induce the agriculturists to adopt any one system of farming. No, sir, upon that area, were the works in operation at this moment, there would be found all descriptions of farming, high and low, good and bad; and any calculations to enable us to find the area, to be satisfactory, must necessarily be made upon that assumption.

Again, sir, if we find it impossible to admit that the highest system of farming can be carried out over the entire area, does it follow that we must adopt exclusively the system for a rotation of ordinary farming crops in the ordinary method; and why would from 200 to 300 tons to the area be the suitable dressing.

Have not late experiments proved to us that sewage may be applied to most crops, and especially to all descriptions of corn in considerable quantities, and with great advantage, during almost all periods of their growth?

I would wish also to observe, that according to the very careful analysis of Messrs. Hofmann and Witt, the London sewage is worth 2*d.* per ton, App. No. 14. ton, and that, consequently, 1,250 tons are equal to one ton of guano. Therefore, Mr. Mechi is in error when he values it only at 1 *d.* per ton, and states that 2,000 tons of it are equal to one ton of guano.

Finally, I would wish, sir, to draw your attention to a very extraordinary omission by Mr. Mechi, which, of itself, were his other calculations correct, must deprive his opinion (as to the area required for the sewage of the metropolis) of any weight. He entirely omits to make any allowance for the farm-yard dung, and other manure, made on the farms upon his area, which must necessarily be brought into the account.

In the Appendix, No. 1, will be found extracted from an unfinished work of mine on "Town Sewage," the details of the calculations I have made to enable me to fix the area required to absorb safely, and with profit to all parties, the sewage of the metropolis, or of any other town, the quantity and strength of the sewage being first ascertained. But here I would wish to draw attention to what I consider the weak point in those calculations. In them I make considerable use of a letter I received last May from the Earl of Essex, in which his Lordship kindly gave me, at great length, the results of his experiments with the sewage of Watford, and I assume that like results may be obtained with the same quantities of London sewage; but I cannot do this safely, because I do not know the exact manurial value of the Watford sewage as compared with the London.

And here I would wish to remark upon the great want of correct data under which we all labour, in our efforts to arrive at a correct solution of the sewage question, which, I think, looking at it from all points of view, we must admit to be one of the greatest, if not the greatest, social question of the day. Without numerous and correct data, we can never arrive at a correct solution of this question; but those data are ready in all directions to our hands; they have only to be corrected and arranged. To correct, utilize, and publish those data for the enlightenment of the public must evidently be the first duty of any gentleman who understands his true mission, and to whom a concession of the sewage will be made by the Metropolitan Board of Works.

But, as the collecting, arranging, and publishing those data in a proper form for the public would form only one of the many heavy items of expense which must be incurred to enable us to solve the sewage problem, it will, I think, be evident to all that, before any gentlemen is called on to incur that risk, a proper arrangement should be come to with him by the Metropolitan Board of Works.

I would wish, at this point, to recall your attention to Mr. Pollard's letter to me. I think I have now furnished to you, sir, for the information of the Board of Works, all the information with reference to my proposition called for by that letter, with the exception of the "map and sections showing the area of the intended operations, the levels of its surface, and the lines, levels, and sizes of the intended aqueducts indicating the various kinds of surface soil with which it is proposed to deal, and showing in detail what mode of drainage it is intended to adopt, if any, with the size, depth, and inclination of the several proposed lines of drainage."

This is precisely the information which should be furnished to the Board of Works by any Company or promoter of a Company, proposing to utilize the sewage on their land, as in the case of the Edinburgh meadows. Such a map of, say 100,000 acres, would not, comparatively speaking, cost much labour and expense, still less, if the projected Company proposed to commence its operations with a small portion of land as a specimen. But, as I have already shown in a former part of this communication, such a Company is an impossibility, and would not be tolerated by the public or by Parliament, and I feel confident it would not be sanctioned by the Metropolitan Board of Works.

But such a map as is required, giving such a mass of engineering and geological information, could not possibly be got up under an expenditure of 2 *s.* 6 d. per acre. Now, as there are 640 acres in a square mile, and 1,680 square miles in the area over which my works will extend, this map would therefore cost me 134,400 *l.* Such an expenditure as this is quite beyond my reach, or, I should say, of any other promoter of such a method of utilizing the sewage in a liquid state, as I have done myself the honour to make to the Metropolitan Board of Works, which, as I have, I think, proved, is the only method of so utilizing it with the Board of Works, acting in the interest of the ratepayers and the general public, can sanction. It, therefore, follows that if this map is insisted on by the Metropolitan Board of Works, an enormous, if not a fatal obstruction will be thrown in the way of the proper utilization of the sewage, and by that body whose peculiar duty it is to guard the rights and interests of the ratepayers, whose property the sewage is. But such a map is really not necessary to enable the Metropolitan Board of Works "to test the scheme in an engineering point of view," as it is patent to all, that from Hampstead and Shooter's Hills, or from other high lands in the neighbourhood of London, I can dominate over a much greater extent of country than is required for my area.

I would also here remark, that Parliament, when I am applying for my Bill, will not require from me such a map, nor any other than such as is required under the same circumstances from a gas or waterworks company. All that Parliament would require from me would be a map showing the proposed site of my pumping stations, and the site of my tanks on Hampstead and Shooter's Hills, together with the line of mains connecting the two. But, as already shown, I cannot at present give a map of my proposed reservoirs on those hills, as I cannot determine the exact height at which I must place them, until I have first made a rough survey of my area. Even this is an expense which I do not think, sir, that on reconsidering the subject I shall be called on to incur, it being, as I have already had the honour to remark, quite unnecessary for any useful purpose.

Finally, I would wish to recall to your recollection the suggestions of heads of a contract between the Metropolitan Board of Works and myself, which the Messrs. Poole, Johnson and Co., of New Square, Lincoln's-inn, forwarded to you, sir, in March last, for the information of the Board of Works.

They are, to the best of my recollection, as follows:—

"11A, Hart-street, Bloomsbury-square.

APPLICATION of Mr. Thomas Ellis, Builder and Contractor to the Honourable the Board of Works, for a concession of the Sewage of London, upon the following terms:—

1st. That a company be formed for the application of the sewage (in a liquid state) to the land.

2d. That the Company receive the sewage of the Board of Works from the outfall tanks proposed to be constructed by the Board, and the Company be permitted to use such tanks and reservoirs.

3d. That, for the purpose of distributing the sewage, the Company undertake to erect all necessary machinery, and construct all necessary works.

4th. That, previously to the sewage being applied to the land, it shall be completely freed from all offensive smell, if so required, by the Board of Works.

5th. That the duly appointed officers of the Board of Works shall, at all times, have free access to the Company's Works; and that the Board shall, on their report, have the absolute power (upon giving a written order to that effect) to immediately suspend the further distribution of the sewage, should it at any time be found in a state likely to cause a nuisance, but that such suspension of the works shall at once cease upon the sewage being fully deodorised.

6th. That the Company be empowered to let flow any or all of the sewage into the river, provided that, from any accident to the machinery, or other cause, the entire amount of the sewage, or any portion of it, cannot be applied to the land; the Company undertaking, in such case, that previously the sewage shall be deodorised and precipitated.

7th. That the Company undertake all liabilities of legal proceedings in case of nuisance in the application of the sewage, or any of the operations of the Company.

8th. That, from the revenue derived from the sale of the London Sewage, the Company be in receipt of a preference dividend of 5 *l.* per cent. per annum upon the amount of the paid up capital of the Company. The remainder of the profits, after such deduction, to be equally divided between the Company and the Board of Works.

9th. That the management of the Company be vested in a Court of Directors, one-half of whom shall be elected by the shareholders of the Company, and one-half nominated by the Board of Works (if they so desire it) from their own body, such last mentioned Directors to remain on the direction only so long as they shall continue members of the Board of Works.

10th. That the concession of the sewage by the Board of Works shall be in perpetuity, and shall be granted to Mr. Thomas Ellis, the promoter of the Company, conditionally upon the Company being formed upon the above terms, or such alterations of them as may be mutually agreed upon between all the parties concerned.

From the above, sir, it will be seen that I am anxious to give (with a view to prevent all "fear of nuisance") such a control over the operations of the Company to the Metropolitan Board of Works as will render it absolutely impossible for the Company "to infringe the Act of Parliament relating to the subject;" and although, as has been seen, I by no means approve of deodorising the sewage, thinking it unncessary, yet I put it absolutely in the power of the Board of Works to compel the Company to deodorise, should the Board of Works at any time consider it proper to do so.

With reference to deodorising the sewage before applying it to the land, a very erroneous opinion seems to prevail, that we must necessarily precipitate if we deodorise, thus reducing the manurial value of the sewage, and burthening ourselves with a "heavy deposit." This opinion seems to me to have for its foundation the fact, that up to the present moment, the object sought for by all chemists, who have experimented upon sewage, has been to obtain the greatest amount of deposit, and to render the supernatant water as apparently pure as possible, thus reducing (for even they could not entirely destroy) its manurial value.

But, sir, another result must now be sought for; if we are to deodorise the sewage before applying it to the land, we must simply "deodorise," free it from smell and nothing more. I again repeat, I do not think it would be found necessary to deodorise the sewage, but I feel that, for a time, prejudice and ignorance may be too strong for me, and that therefore, should the Metropolitan Board of Works grant me a concession of the sewage, I must be prepared with such a deodoriser. But science has not yet, as far as I am aware, discovered it or even sought for it; does it therefore follow that we cannot obtain it?

Upon this point I have already consulted that eminent analytical chemist, Dr. E. Frankland, of St. Bartholomew's Hospital, and the following is the copy of a letter from that gentlemen:—

"Chemical Theatre,
"St. Bartholomew's Hospital,
"Sir, 26 July 1861.

"In reply to your question, relating to the effect of deodorisation upon the manurial value of sewage, I have to state that, in my opinion, the London sewage may be effectually deodorised, without reduction of its manurial value to any important extent.

"I am, &c.,
(signed) "*E. Frankland.*

"Thomas Ellis, Esq."

In a subsequent letter, dated 27th July, he states:

"I am in receipt of yours of to-day. In reply, I beg to say that the statement of my opinion which I sent you previously, coupled with the remarks in the reports of Dr. Hofmann and myself, ought to go far towards convincing the Board of Works, that so far as deodorisation, manurial value, and nuisance are concerned, your scheme is feasible. Without careful experiments upon the sewage, I cannot express a more decided opinion, although I cannot but regard the probable result of those experiments as very hopeful. I trust you will not find the objections of the Board so formidable as you anticipate; but if you go to Parliament you must have a careful experimental basis to work upon."

That basis, founded upon numerous and costly experiments, is but one of those many items of expenditure which must of necessity be incurred if this great question is to be solved, but which cannot, of course, be thought of by any promoter of a Company until a concession be first agreed to by the Board of Works.

While on the subject of possible nuisance to the public from the working of the Company, allow me to refer you again to my suggestions for a conditional concession, and you will see that from the absolute control I place in the hands of the Board of Works, I put it entirely out of the power of the Company to "infringe the Act of Parliament relating to that subject;" and you will be pleased to recollect that, as the Company which I promote cannot possibly commence its operations, nay, more, cannot proceed to lay down its works without first obtaining an Act of Parliament, there can really be no danger to the public comfort or health from us, for unless we can satisfy a Parliamentary Committee, not alone on this point, but on many others, we will not get our Act, and therefore will not have it in our power to become a nuisance to anyone.

There is one more point in my application for a concession to which I wish to draw your attention, and that is, that it should be made to me "in perpetuity."

It may be said that, by the Act of Parliament under which the Metropolitan Board of Works takes all its rights, it has not the power to grant the application; I have not seen the Act, and am therefore not aware whether this be so, nor does it signify, for should such prove to be the case, then my application may be modified thus: Give me a concession of the sewage for the utmost extent of time within your power, and your consent and approval in the interest of your constituents, the ratepayers, to my application to Parliament for a perpetuity of tenure, under terms which shall be agreed on between the Board of Works and myself.

Parliament, assuredly, would not refuse such an application, as it is self-evident that such an amount of capital as is required to execute the works necessary to utilize, in a liquid state, the sewage of the metropolis, never could be raised except on a perpetuity of tenure.

But as a perpetuity of tenure by the Company might perhaps hereafter interfere in some way with the interest or the comfort of the public, I would consent that Government should have the same powers over the Company as I understand they have over all railway companies, the right to purchase up our property on a valuation after the lapse of a certain number of years.

In the above observations I have, sir, endeavoured, as briefly as possible, to explain what were the foundations for that most mistaken idea that "it was an engineering and commercial impossibility to utilize, in a liquid state, the sewage of the metropolis." So far from such being the case, the utilization of the sewage in the liquid form must, as I think I have shown by my plan and estimate, be one of the most brilliant commercial successes ever achieved in England.

This is not difficult to be understood, if we merely consider the great return to the shareholders upon their outlay, selling the sewage at only 2 *d.* per ton.

Assuming that the annual bulk of the sewage amounts to 266,052,441 tons, and that the outlay to utilize that amount of sewage would be 6,200,787 *l.*, and the annual working expenses, as shown in the estimate, 332,125 *l.*, we would have a gross profit of 30·4 *l.* per cent., which, being divided as suggested between the Company and the Metropolitan Board of Works as the trustees of the ratepayers, would place at the disposal of the Board of Works, for the reduction of taxation upon the metropolitan area, or for necessary metropolitan improvements, no less a sum than 787,439 *l.* per annum, and would leave for the shareholders of the Company 1,097,540 *l.* per annum, or 17·7 *l.* per cent. upon the outlay; a return sufficiently large to enable me with ease to raise the required capital; but, as explained in a previous part of this letter, the return to the shareholders and also to the ratepayers must in reality be still greater.

In the success of my application the ratepayers of the metropolis have a vital interest; but great as is that interest it sinks into insignificance when we consider the interest of agriculture and the general public.

We see, sir, from the works of Liebig, and other great thinkers of the age, the enormous and dangerous loss that agriculture in this country sustains from the waste of its manure in the metropolis, and the other cities and great towns, which puts us virtually "at the mercy of those who may at any day become our enemies."

May we not, then, fairly assume that the leaders of agriculture in England, who have so deep a stake at issue, if a feasible plan for utilising the sewage of the metropolis and our other large towns, for rescuing that which is now lost, and restoring it to the land, be placed before them, may we not fairly assume that they will give that plan their hearty support? and thus it is that upon the direction of my projected company will be found some of the first names in England.

But, sir, great as is the stake at issue for the ratepayers of the metropolis and of agriculture, shall we find the inhabitants of the other cities and large towns in Great Britain indifferent to the solution of this great question? Have they no stake at issue, which, as rational men, will coerce them also to give to us their hearty support.

Do we not know that if we here work out the solution of this great social, aye, and national, question, do we not know that our example will be followed elsewhere, and that the sewage of our cities and great towns, instead of being, as at present, the prolific cause of disease and death to our citizens and a danger to the prosperity of agriculture in England, instead of being, as at present, a curse, will become a blessing to our native land.

But, sir, although the utilization of the sewage of the metropolis in the liquid form can be so easily effected, and with such great benefit to the ratepayers and the general public, does it follow that my application for a concession of the sewage (to be so utilized) will be granted by the Board of Works, or rather, I should say, do they still consider that they possess the power to grant it.

How stands the case?

In March last my application for the sewage was laid before you, sir, for the information of the Board of Works, and I was then as ready as I am now to proceed with this matter. Had my application been then entertained, my capital in all probability would have long since been raised, and I should have been in a position to go to Parliament next Session for my Act.

This delay in coming to a decision on my application was no doubt caused by the great pressure of other matter upon the Board; but, sir, I would respectfully submit that there is no business that could by any possibility come before the Board of one-tenth part the importance to the over-taxed ratepayers of the metropolis as is the proper and prompt solution of the sewage question.

Several of my supporters, seeing the delay which was taking place in the settlement of this great question, have from time to time urged me to go to Parliament for my Act without waiting any longer for the decision of the Board of Works; but I have invariably refused to do so, thinking it would be highly disrespectful to the ratepayers, whose property the sewage is, and to the Board of Works, the guardians of that property, were I to attempt to deal in any way with that property without having previously received their consent.

But, sir, what has been the result of this deference on my part to the feelings of the ratepayers and of the Board of Works? What has been the result to me, aye, and to the ratepayers also? Just this, that at the last moment, when it is impossible for me by any act of my own to obtain a *locus standi* before Parliament next Session for my Company, I find my application for the sewage will be burked, and the interests of the ratepayers utterly sacrificed by the act, I might almost say, the trick of a projected Company, which, I feel assured, will receive no countenance or support from the Metropolitan Board of Works.

I stop the printing of this letter to say, that I have just been informed that this projected Company (unheard of by me, and I think by all other gentlemen who have submitted their plans to the Board of Works up to the present moment) has lodged the necessary notices to enable it to apply to Parliament next session for powers to deal with the sewage of the metropolis, and this it has done without first receiving for its plan the approval of the Board of Works.

But, sir, discourteous as such a proceeding is, and offensive as it must be to the feelings of the Board, I cannot but admit that the Honourable William Napier, the promoter of this Company, calling itself "The London Sewage and Essex Reclamation Company," has exhibited a large amount of worldly prudence, as I shall presently show, that by no other means than such a surprise to all parties had he the slightest chance of success.

It remains now, however, with the Metropolitan Board of Works alone, to decide whether that chance of success shall become a comparative certainty, as it cannot be supposed that any one of the gentlemen having plans before the Board would incur the expense of a Parliamentary contest with this projected company (even if a *locus standi* before Partiament could yet be obtained), unless the Board of Works would first grant a concession of the sewage. But the Board of Works will, I have no doubt, at once take such steps as may be necessary to vindicate its own authority, and to protect the rights and interests of the ratepayers.

This company proposes, I am informed, to deal with 20,000 acres of land on the coast of Essex, comprising the Foulness and Dingie Sands, to convey the sewage of the north side of London from the outfall tanks by 37 miles of 10 feet conduit, with open branches, to Crosneath, and south of the River Crouch seven and eight miles respectively. They propose a pumping lift about nine miles from Abbey Mills to lift the sewage 30 feet high by means of steam-engines; and the cost of their works, they say, will be 2,000,000 *l.*

I have not been on the sands which it is proposed to reclaim, but I am told that to enable this company to reclaim these sands, it will be necessary to erect a very costly embankment to shut out the sea, and they will have also to prepare and lay down the sands to enable them to irrigate for meadow, which, I presume, would be their plan. As, however, I have not been informed whether these 37 miles of 10 feet conduit are to be constructed of brick or of iron, I have not attempted to make an estimate of what the true cost of these proposed works would be; but it must, I think, be evident to any engineer or contractor that such works could not, by any possibility, be executed for anything like two millions sterling. That, however, is a question more for the consideration of those who propose embarking their money in the speculation than for the Board of Works, except as it may affect the prospects of the ratepayers as to their chance of getting a return from the company for their property, the sewage.

What that chance amounts to, may be seen from the following simple calculations:—

The annual volume of the sewage of the north side of the metropolis amounts to 36,967,285,300 gallons, or 5,973,577,238 cubic feet, or 168,033,115 tons, and, if placed on 20,000 acres, would give us a depth of 6·9 feet, or 8,402 tons of sewage per acre. which, at 2 *d.* per ton, would amount to 70 *l.* 0 *s.* 4 *d.*

Now, at Edinburgh, the proprietors of the Craigentinny meadows only obtain 40 *l.* per acre per annum, for the produce, as has already been shown. The London Sewage and Essex Reclamation Company cannot, I think, well expect to obtain more, if so much, as the enormous quantity of meadow which they will each year throw on the market must, of necessity, have a prejudicial effect on their returns.

It follows, therefore, that merely calculating the actual value of the sewage, without making any allowance for the cost of management, &c., &c., there must be a loss to this company of 30 *l.* 0 *s.* 4 *d.* per acre, provided they pay for the sewage at the same rate (2 *d.* per ton), as I propose to charge the consumers of it under my plan. I am, therefore, not surprised to hear that they have made no offer whatever of any payment, and if they can get the sewage on those easy terms, their speculation may be a profitable one for the shareholders, although as much cannot be said for the overtaxed ratepayers of the metropolis; but even if this company did offer to pay for the sewage, it is self-evident they never, under any circumstances, could afford to pay such a price, or to offer such terms as I propose. I need not, I think, sir, direct your attention very particularly to the pestilential effect of pouring such an enormous amount of sewage on so limited an area of low lying and imperfectly drained sand, which would, therefore, be unable to absorb and deodorise it with sufficient rapidity; that is quite self-evident. Neither will it be necessary that I should recapitulate the reasons I have already given to show that a company such as this, which proposes to use the sewage on its own lands, is in every way opposed to the true interests of agriculture, and of the general public. It is sufficient to show, as I think I have done, that such a company cannot, by any possibility, make a proper return for the sewage to the true owners of that sewage—the overtaxed ratepayers of the metropolis.

But, sir, while all this is so evident, the fact remains that this projected company alone, of all those which have their plans before the Metropolitan Board of Works has obtained a *locus standi* before Parliament, and that in all probability, they will obtain their Act, unless the promptest steps

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steps are taken by the Board of Works to prevent them. But these steps can be taken by the Board without trouble, and without any expense. All that is necessary for the Board of Works is, to summons before them the promoter of this projected company, as well as all those other parties whose plans have now for so long a time been under consideration, and after examination of those plans by the Board of Works, let the Board give a conditional concession of the sewage to whatever party lays before them the best and most feasible proposition.

Should that decision be, as I think it will, adverse to the London Sewage and Essex Reclamation Company, they must of necessity submit to it, and stop those proceedings which they have commenced, as Parliament would then certainly refuse to give them powers to deal with that sewage which was already disposed of by the Board of Works. And I venture to hope that the Metropolitan Board of Works will not reject this suggestion, when they consider that in granting a conditional concession, they really do no more than give permission to certain parties to lay before Parliament a certain plan for dealing with the sewage, which plan will then receive before the Committees of both Houses, a most searching and public examination, and should the promoters fail in supporting their calculations, their application for an Act will be refused. The conditional concession will by that failure be forfeited, and the Metropolitan Board of Works will then be once more free to deal with any other party. By adopting this plan, the Board will secure in the interests of the ratepayers, and without any expense to them, the most thorough and public investigation of the entire question.

But it may perhaps be said, "why not let things remain as they are, and if the London Sewerage and Essex Reclamation Company fail to support their plan before Parliament, they will not get their Act, and then no wrong will be done to the ratepayers?" To which I would reply, that it is clear no persons should be allowed, without opposition, to apply to Parliament for powers to deal with the sewage until those parties had first received permission to do so from the trustees of the owners of that sewage. Now, the Board of Works as such trustees, can scarcely grant such permission for any promoter of a company who does not show a feasible plan, and offer fair terms to the ratepayers; how then can it be supposed that the Board of Works could give their sanction to the London Sewage and Essex Reclamation Company, whose plan is not feasible, and who offer to the ratepayers no return whatever for the sewage? But, sir, were the Board of Works to remain quiescent on the present occasion, it might be supposed by the public, and probably by Parliament, that the plans of this projected company were approved of by them, and thus place all parties in a false position, more especially so, as the Board of Works will, I understand, be obliged to go to Parliament next Session for an Act to give them increased powers of local taxation to enable them to carry on works of absolute necessity, but for which they have not at present sufficient funds. But such increase of local taxation would perhaps be entirely unnecessary, were the sewage utilized by a Company such as I promote, which offers to place a sum of not less than 700,000*l.* per annum at the disposal of the Board of Works for the reduction of local taxation.

Apologising for the great length to which this communication has run, I have to request, sir, that you will be pleased at your earliest convenience to lay it before the Metropolitan Board of Works.

I am, &c.
(signed) *Thomas Ellis.*

APPENDIX, No. 1.

ROUGH CALCULATIONS to enable us to determine the probable Area required for the Metropolitan Sewage.

To find the quantity of London sewage manure likely to be absorbed on a given area, we must first ascertain the quantity of farmyard dung which can, under the most favourable circumstances, be produced on the same area; it being understood that the lands on that area are self-supporting, that is, no food is consumed by the cattle, except that grown on the land, and no manures purchased.

We already know, by a long course of experiments made by the best farmers of the day, the exact quantity of farmyard dung per acre required to produce first-class crops. If, then, on land entirely self-supporting, that is, where no manures are purchased, or any food consumed by the cattle, except that grown upon the land, that amount can be produced, it follows that no sewage or other extraneous manures will be required; but if it cannot, then the difference between the two amounts is the equivalent of the sewage, per acre, likely to be absorbed on a given area, provided it can be supplied to the farmer at as low a price as any other manure.

Now, the higher land is farmed, the greater will be the quantity of manure produced on that land; and, therefore, the smaller the deficiency to be supplied.

Let us see, therefore, the maximum quantity of manure which, under the best systems of cultivation (if self-supporting), can be produced on a given extent of land.

The best authority on the point is, "Morton's Cyclopædia of Agriculture," published in 1855. At page 319, Vol. II., we find it stated that,—

There are three marked systems of cultivation which have established themselves in this country, viz., the four-course, or Norfolk system; the five-course, or Northumberland system; and the six-course, or East Lothian system.

By the first, or Norfolk system, we have, on a farm (say, for convenience of calculation), of 120 acres, 30 acres of wheat, 30 of turnips, 30 of barley, and 30 of clover and Italian rye-grass; assuming a fixed amount of bushels of grain for the different rotations, and calculating, from a great number of data, the quantity of straw yielded, per bushel, on well-cultivated land, and also the quantity of green crops grown, we shall be able to arive at an approximation

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proximation as to the whole manure actually produced and made on a farm under the different systems specified.

The average yield of wheat upon well-cultivated farms is, according to an average taken from a great number of experiments whereon artificial manures had been applied, 30 bushels, yielding a fraction more than 100 lbs. of straw to every bushel of grain. Of oats, the yield may be taken at 48 bushels, each bushel yielding 78 lbs. of straw. Of barley, the yield was a little more than 41 bushels, or say 48 bushels, and 70 lbs. of straw to the bushel. Swedes, 17½ tons; yellow turnips, 20 tons; and white, 22½ tons. Of beans, the yield and proportion of straw to the grain is more variable; and having few published data to go by, we assume the yield to be as 28 bushels, and 30 cwt. of straw.

Upon a farm of 120 acres, cultivated upon the four-course system, there will be of straw and turnips as follows:—

	Tons	*cwts.*	*qrs.*	*Tons*	*cwts.*	*qrs.*
30 acres wheat, 27 cwt. straw per acre	40	10	0			
30 acres barley, 25 cwt. ditto	37	10	0			
7½ acres hay, 30 cwt. ditto	11	5	0			
Dry food and litter	-		-	89	5	0
7½ acres grass, consumed 120 cwt. per acre	45	0	0			
15 acres turnips, in-doors, 20 tons per acre	300	0	0			
15 acres turnips, fed off		—				
120		—				
15 acres aftermath, consumed green 60 cwt. per acre	45	0	0			
Total year's food	-		-	390	0	0
				479	5	0
Supposing the stock in-doors, consisting of 4 horses to work the farm, and 16 bullocks, box-fed, the distribution of food and litter would be as follows:—						
4 work-horses will consume of hay, as fodder, in 8 months, or 243 days, 1½ stone each per day	9	2	1			
Straw, as litter, for the same time, 1 stone per day each	6	0	2			
Green food, 122 days in summer, 6 stone each per day	18	6	0			
Straw, as litter, during that period, 1 stone each per day	3	1	0			
				36	9	3
16 full-sized cattle will consume, and fatten upon, 200 lbs. of turnips each, per day, for 210 days	300	0	0			
Litter and fodder for same period at 3 stone each per day	63	0	0			
				363	0	0
8 bullocks will consume of cut grass, in 4 months, 168 lbs. per day	71	14	0			
Litter for same period, 19 lbs. each per day	8	1	1			
				79	15	1
				479	5	0
By the five-course, 120 acres. This rotation in Norfolk is: 1st, grass; 2d, grass pastures; 3d, wheat; 4th, turnips; and 5th, barley.						
The following may be taken as a fair average of this rotation:—						
48 acres wheat, oats, and barley, in equal proportions, at 27⅔ cwts. of straw per acre	66	8	0			
7½ acres hay, 30 cwt. per acre	11	5	0			
Dry food	-		-	77	13	0
3 acres grass, consumed by horses, 120 acres	18	6	0			
37½ acres grass, fed off		—				
24 acres turnips, consumed by cattle in boxes	280	0	0			
				298	6	0
				375	19	0

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	Tons	cwts.	qrs.	Tons	cwts.	qrs.
Winter food for four horses:						
Hay, 243 days, 1½ stone each	9	2	1			
Straw litter, for the same period, 1 stone each per day	6	0	2			
Summer food:						
Cut grass, 122 days, 6 stone each per day	18	6	0			
Straw litter, for same period, 1 stone each per day	3	0	0	36	8	3
15 cattle, consuming as at the rate of 200 lbs. each, will finish, in 209 days	280	0	0			
Fodder and litter for same period	58	15	2½	338	15	2½
				375	4	1½

Six-course of 120 acres. This course in Scotland is, 1st, wheat; 2d, turnips; 3d, barley; 4th, grass; 5th, oats; 6th, potatoes and beans, or, one-half corn and one-half green crops. The distribution of crops is different in Norfolk; there the 6-course consists of 1st, wheat; 2d, barley; 3d, turnips; 4th, barley; 5th, grass; 6th, grass or corn, and green crops half-and-half. In both cases the turnips occupy one-sixth of the land, so that the manure-making materials will, in the latter, only vary in amount in proportion to the quantity of grass consumed in the green state, or made into hay.

The Scotch rotation is selected in preference, because of the equal distribution of the crops, and also because no two white crops follow in succession.

The amount of food and consumption may be stated as follows:—

	Tons.	cwts.	qrs.	Tons.	cwts.	qrs.
20 acres wheat, at 27 cwts. of straw per acre	27	0	0			
20 acres barley, at 25 cwts. of straw per acre	25	0	0			
20 acres oats, at 30 cwts. of straw per acre	30	0	0			
7 acres hay, at 30 cwts. of straw per acre	10	0	0			
19 acres beans, at 30 cwts. of straw per acre	15	0	0			
Total dry fodder	-		-	107	0	0
3 acres grass consumed by horses, 120 cwts.	18	0	0			
10 acres grass fed off		—				
20 acres turnips consumed in-doors, 20 tons	400	0	0	418	0	0
19 acres potatoes sold off		—				
10 acres aftermath consumed in-doors, 60 tons		—				
Total green food	-		-	30	0	0
Winter food for horses:				555	0	0
4 work horses, hay 243 days, 1½ stone per day	9	2	1			
Straw litter for same time, 1 stone each per day	6	0	2			
Summer food for horses:						
Cut grass for 122 days, 6 stone each per day	18	6	0			
Straw litter, 1 stone each per day	3	1	0	36	9	3
21 cattle; 200 lbs. of turnips each for 213½ days	400	0	0			
Fodder and litter for same time, 3 stone each per day	84	1	1	484	1	1
Summer food for cattle:						
4 cattle, 168 lbs. grass each per day for 100 days	30	0	0			
Straw litter for 100 days, 1 stone each per day	3	15	0	33	15	0
				554	6	0
1 ton of straw over	-		-	1	0	0
				555	6	0

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By the 4-course rotation, the whole turnips, grass, and straw consumed by the cattle amount in round numbers to 393 tons, which gives 295 tons of manure, and, with the litter added, amount to 345 tons. The dung from the food consumed by the horses and taken from the stalls, will depend greatly on the time occupied at work or in the stable; but taking our former data to govern us, the dung actually collected from four horses, fed as already stated, will be rather more than 34 tons annually. Adding the whole dung litter and urine together, the result is 379 tons as the total amount of manure made on a farm of 120 acres, farmed on the 4-course shift, or fully 12½ tons per acre for the 30 acres of green crop.

By the 5-course system the numbers will stand thus:—

Turnips and fodder consumed = 300 tons = 225 tons of manure × litter 40 tons = 265 tons of manure, which added to that of the horses, gives 299 tons altogether, or nearly 12½ tons per acre for the 24 acres of green crop.

By the 6-course rotation, turnips, grass, and litter consumed 458 tons = 343½ tons of manure × 60 tons of litter = 403½ tons of manure, which, added to that by the horses, gives 437½ tons altogether, or nearly 11 tons of manure per acre for the 40 acres of green crop.

It will, however, be observed, with regard to these data, that by the 1st rotation the land is dunged every fourth year, in the 2d every fifth year, and in the 3d every third year, or twice during the rotation.

By the 4-course, 3·16 tons of manure are made annually for every acre on the farm.

By the 5-course, 2·5, and by the 6-course, 8,364 tons.

It is evident, therefore, that the 6-rotation produces more manure than either of the others, notwithstanding that one-sixth part of the green crop (potatoes) is annually sold off the farm.

Now, according to "Stephens' Book of the Farm," published in 1851, the following green crops should receive,—

Parsnips.—Twenty-five tons of farm-yard dung per acre in the drills, and four cwt. of guano sown over the drills.

Carrots.—The quantity of manure applied should be 25 tons of farm-yard dung, and two cwt. of guano per acre.

Cabbage.—As the cabbage requires much manure, 20 tons of farm-yard dung per acre should be given, and at least two cwt. of guano sown by hand over the drills.

Potatoes—Require 25 tons of farm-yard dung to the acre.

Kohl Rabi.—With 16 tons of good farm-yard dung, and four or five cwt. of sulphated bones to the acre, a crop of from 20 to 30 tons may be expected to be raised. A sprinkling of two cwt. of guano to the acre, round each plant, would tend to increase the bulk materially.

Turnips.—When farm-yard dung is alone used for manuring the turnip crop, the quantity applied generally differs from 12 to 15 tons to the acre, according to the sort of turnip; the Swedish variety receiving the larger quantity, and the white the smaller.

In the neighbourhood of towns, much more manure is applied—as much as 32 loads, of at least 15 cwt. each of town manure to the acre, and upwards of 20 tons of farm-yard dung.

The more dung the turnip crop receives it will yield the heavier crop; still, if the farmer depend entirely on the sources of the farm for manure, he cannot apply a large quantity to one crop without depriving others of their fair share.

From this it would appear, that to obtain good crops we must give not less than 25 tons of farm-yard manure per acre; but, for the purposes of this inquiry, and to be well within the truth, let us say 22 all round as a standard.

Now, we have already seen that on a farm of 120 acres, cultivated on the self-supporting system, there can only be produced, under the most favourable circumstances, by the 4-course, 379 tons, or 12½ tons per acre for the 30 acres under green crop. This will give 9½ tons short of the proper quantity per acre (22), or 285 tons on the 30 acres.

If, then (as is the case), one ton of average farm-yard dung is worth 5*s.* it will be equal, in cost, to 30 tons of the London sewage, at 2*d.* per ton, and about equal as manure; therefore, 285 tons of farm-yard dung deficient = 8,550 tons of London sewage.

That, then, is the exact quantity of sewage which is required on the 30 acres of green crop, in addition to the utmost amount which can be manufactured on the farm.

By the 5-course system we get 299 tons, or nearly 12½ tons per acre to the 24 acres under green crop, leaving a deficiency also of about 9½ tons per acre, or 228 tons on the 24 acres of green crop = 6,840 tons of sewage.

By the 6-course system we get 437½ tons of farm-yard dung, or nearly 11 tons per acre on the 40 acres under green crop. The deficiency in this case, amounting to 440 tons on the 40 acres = 13,200 of sewage.

But we have not, as yet, considered the quantity of manure which, by practice, it has been found desirable to apply to the other crops grown on the remainder of the 120 acres.

By the 4-course system there would be, in addition to the 30 acres of green crop, 30 acres of wheat, 30 acres of barley, and 30 acres of clover and Italian rye grass.

Now, Lord Essex, who has for some time rented the sewage of the town of Watford, writes to me:—

"On wheat I have only tried it once, as an experiment, on two acres. I applied 60,000 gallons each (about 270 tons = a depth of 2·7 inches), and the result, as against two adjoining acres, was a clear gain of 2*l.* 7*s.* per acre in corn and straw. I should use it more extensively for wheat if I could spare it from my rye grass."

If, then, we apply a dressing of 270 tons of sewerage per acre, on the 30 acres of wheat, we will require 8,190 tons. A like dressing for the 30 acres of barley, also 8,190 tons.

On the Italian rye grass Lord Essex informs me that he gives eight dressings, of 270 tons per acre, each with the greatest success. These dressings would require 64,400 tons of sewerage for the 30 acres of clover and Italian rye grass.

Thus, for the crops grown on the farm, excluding the green crop, there would be required 78,780 tons of sewerage; or, with the 7,550 required for the green crops, in addition to the farm-yard dung, 87,330 in all, or nearly 728 tons per acre = a depth of 7· inches.

By the 5-course system there would be 48 acres of wheat, oats, and barley, in equal proportions. If we dress this with 260 tons to the acre, we will require 12,480 tons, 48 acres grasses; this dressed eight times with 270 tons per acre each dressing, gives us 99,840 tons; and the 24 acres of turnip,

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for which the manure of the farm is deficient, 9½ tons per acre, or 240 tons = 6,840 tons of sewage—making the total amount of sewage required for this 120 acres farmed on the 5-course system, 119,160 tons, or over 993 tons per acre.

By the 6-course system we have 60 acres of wheat, barley, and oats, in equal proportions. One dressing to this, of 260 tons to the acre, requires 15,600 tons; 19 acres of beans, 260 tons to the acre = 4,940 tons; 21 acres of grasses, 260 tons to the acre, dressed eight times, require 43,680 tons. Then, 20 acres of turnips, deficient 11 tons of dung per acre = 220 tons of farm-yard dung = 6,600 tons of sewage; 19 acres of potatoes, deficient 11 tons of dung per acre = 209 tons of dung = 6,270 tons of sewage. The entire quantity of sewage required on this 120 acres, farmed on the 6-course system, is 77,090 tons, or over 642 tons to the acre = a depth of 6·2 inches.

Now, if we assume for a moment that all the land included within the area proposed to be irrigated with the London sewage is farmed in the best manner, according to these three systems (they being the best known), and self-supporting, we find that we would require, on an average, over 787 tons of sewage per acre = a depth of 7·7 inches, in addition to all the manure that could be produced on the land. But this would not be a correct assumption, as a large proportion of the land within the area would be found to be cultivated on other systems; not so manure, producing, and therefore requiring more sewage, and this more particularly would be found to be the case on permanent grass land.

It has been found that grass land will absorb enormous quantities of sewage, making returns in proportion to the manure it receives.

On the Carrigentinny meadows, at Edinburgh, which were originally quite barren, as much as 8,490 tons to the acre is given per annum = depth of 6·9 feet. This amount renders the land too soft for grazing, and is a most wasteful expenditure. On land, therefore, devoted to grazing, a less quantity should be used, say 3,000 tons = a depth of 2·4 feet; but to be well within the truth, let us say for meadow land, 3,000 tons, and for grazing 1,000 tons per acre.

Now, if we divide the entire area that is to be irrigated by the London sewage, thus, say two-thirds under tillage, requiring 787 tons of sewage on an average, per acre, and one-third under permanent grass. Of this one-third, two-thirds will be under grazing, requiring 1,000 tons per acre, and one-third under meadow, requiring 3,000 tons per acre. This would give us, as the general average (over the entire area), 1,595 tons of sewage to the acre = a depth of 1·3 feet, provided that sewage alone was used in addition to the farm-yard dung. But such would not be found to be the case; other manures would still be used as well as sewage. It is not by any means probable that any one manure could fill the place of all others, nor would it probably be good for the land that it should; but, inasmuch as sewage contains the component parts of most other manures, and as it can be applied at all periods of the growth of the plant, while no other manure can, and especially in hot summers, when a copious use of sewage would produce almost a tropical growth, it is more than probable that on any area where sewage could be had at a reasonable rate, it would supply at least two-thirds of whatever manure was required to be purchased, or a general average of 1,064 tons per acre = a depth of ·87 feet. But, to allow a margin for undrained lands, &c. &c., let us again reduce the average quantity to, say, 1,000 tons to the acre, over the entire area. As, however, I consider that it is desirable, in the interests of the company, to keep the supply of sewage well under the demand, and thus to secure a good price for the article, I have made my calculation for an area of such extent as only to afford an average supply of 500 tons to the acre = a depth of 4·9 inches, which, as it will be applied not in one dressing, but spread over several, cannot possibly be injurious, or even offensive to the public.

APPENDIX, No. 2.

ROUGH ESTIMATE.

THIS rough estimate is made greatly in excess of the true amount, for the reasons stated in my letter to the Chairman; the true amount will not exceed 3,500,000 *l.*

Engines and Buildings—(constant in all areas).

The reservoirs to be constructed by the Board of Works will, as far as can yet be learned, be of the following dimensions:—

North side	- -	12 acres by 15·5 feet deep.
South side	- -	7 acres by 15·5 feet deep.

These are to contain the average amount of sewage generated in 12 hours, consequently the cubic contents of these reservoirs will form the limit of the maximum bulk of sewage to be pumped in 12 hours.

Content of North Side Reservoir:
= 12 acres × 15·5 feet,
= (12 × 43,560 × 15·5) cubic feet.

There being 43,560 square feet in an acre,
= 8,102,160 cubic feet.

Dividing this by 12 × 60 for the quantity per minute,
= 11,253 cubic feet.

Multiplying by ·02841 for the same in tons,
= 319·8 tons,
= 716,352 pounds.

This is supposed to be lifted to Hampstead (431 feet high), called 460 feet in order to meet correction* as much as possible for depth of wells or tanks from which the sewage may be pumped. * Vide note (a)

∴ Net horse-power for the north side,
= 716,352 pounds × 460 feet + 33,000,
= 9,985·5 horse-power.

Content of South Side Reservoir:
= 7 acres × 15· feet,
= (7 × 43560 × 15·5) cubic feet,
= 4,726,260 cubic feet.

Dividing this by 12 × 60 for the quantity per minute,
= 6,564·2 cubic feet.

Multiplying by ·02841 for the same in tons,
= 186·5 tons,
= 417,760 pounds.

This is supposed to be lifted to Shooter's Hill (412 feet high), called 440 feet in order to meet correction† as much as possible for wells or tanks from which the sewage may be pumped. † Vide note (b.)

∴ Net horse-power for south side,
= 417,760 pounds × 440 feet + 33,000,
= 5,570·1 horse power.

Net horse power for north side - = 9,985·5
Ditto south side - = 5,570·1

TOTAL - - 15,555·6

For friction spare power, &c. $\frac{15}{8}$ of the net horse-power is assumed to be the requisite gross horse-power ("Hughes on Waterworks.")

$= \frac{15}{8} \times 15,555·6$
= 29,167 gross horse-power.‡ ‡ Vide note (c.)

Cost of erecting engines and buildings, £40 per horse-power.
= (40 × 29,167) in £'s.
= £1,166,680.

Mains—(constant in all areas).

The rate of flow maintained in the mains is 2·5 miles per hour§ assumed. § Vide note (d.)

Volume flowing through the mains on the north side in 12 hours:—
= 8,102,160 cubic feet,
675,180 cubic feet per hour.

Letting x = bore of the main,
x × 2·5 miles = 675,180 cubic feet,
or x × 13,200 feet = 675,180 cubic feet.

There being 13,200 feet in 2·5 miles.
∴ x = 51·15 square feet.

Dividing this into a set of 3
$\frac{51·15}{3}$ = area of each pipe (in square feet) in the set,
= 17·05 square feet,

Letting d = diameter,
$d^2 \times ·7854 = 17·05$
$d^2 = 17·05 \div ·7854$
$= 21·7087$ feet,

$\therefore d = \sqrt{21·7087}$
$= 4·66$ feet.

The distance from Barking Outfall to Hampstead is about 13 miles. This, then, would be the length of a single main; but in the present case, the main being resolved into 3, will give for a total length of pipe 3 × 13 miles = 39 miles.

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Volume flowing through the mains on the south side in 12 hours:—
= 4,726,260 cubic feet,
= 393,855 cubic feet per hour.

Letting x = bore of main,
$x \times 2{\cdot}5$ miles = 393,855 cubic feet,
$x \times 13{,}200$ feet = 393,855 cubic feet,
$\therefore x = 29{\cdot}84$ square feet.

Dividing this into a set of 2,
$\frac{29{\cdot}84}{2} = 14{\cdot}92$ square feet.
= area of each pipe in the set.

Letting d = diameter,
$d^2 \times {\cdot}7854 = 14{\cdot}92$,
$d^2 = 18{\cdot}9967$
$\therefore d = \surd\,\overline{18{\cdot}9967}$
$= 4{\cdot}36$ feet.

The distance from Plumstead Outfall to Shooter's Hill is about four miles. Total length of pipe is therefore 2 × 4 miles = 8 miles.

4·66 feet diameter pipe weighs about 15·64 cwt. per yard.
4·36 „ „ 14·44 „ „

Now, 39 miles of the 4·66 feet diameter pipe
$= (15{\cdot}64 \times 1760 \times 39)$ cwt.
= 1,376 tons, 6 cwt. × 39
= 53,676 tons;

and eight miles of the 4·36 feet diameter pipe
$= (14{\cdot}44 \times 1760 \times 8)$ cwt.
= 10,166 tons.

North Side mains 53,676 tons.
South Side ditto 10,166 tons.

TOTAL - 63,842 tons.

	£.
This at 5 *l.* 10 *s.* per ton - - - - - - - - - -	= 351,131
Cost of laying, &c., at 2 *l.* per yard (82,720 yards) - - - - -	= 165,440
TOTAL - - - -	£. 516,571

Reservoirs and Wells—(Constant in all Areas).

The reservoirs and wells are considered to be in content equal to twice the sum of contents of the Board of Works North Side and South Side Reservoirs; or 2 × (8,102,160 North side + 4,726,260 South side cubic feet)
= 25,656,840 cubic feet,
= inner content of the wells and reservoirs together.

In order to approximate to the mass of brickwork, &c., entirely irrespective of the form or position of the wells and reservoirs, it is requisite merely to deduce results from any form of equal content.

Supposing the form to be cylindrical, and the depth 30 feet, and letting x = area of the reservoir,
$x \times 30 = 25{,}656{,}840$ cubic feet,
$x = 855{,}228$ square feet,
$= 19{\cdot}6$ acres.

Letting d = diameter,
$d^2 \times {\cdot}7854 = 855{,}228$ square feet,
$d^2 = 1{,}088{,}907{\cdot}56$ square feet,
$d = \surd\,\overline{1{,}088{,}907{\cdot}56}$
$= 1{,}043{\cdot}51$ feet diameter of reservoir.

For the outer content let the inner content be bounded by 1·5 feet of brickwork.
= (diameter + twice the thickness of brickwork)^2
× ·7854 × (depth + twice the thickness of brickwork),
$= \{(1043{\cdot}51 \times 2\,(1{\cdot}5)\}^2 \times {\cdot}7854 \times \{(30 + 2\,(1{\cdot}5),\}$
$= 1046{\cdot}51^2 + {\cdot}7854 \times 33$,
= 28,385,177 cubic feet.

Volume excavated—

$= \frac{1}{2}$ (the outer content — thickness of brickwork at the top),

$= \frac{1}{2}\,(1046{\cdot}51^2 \times {\cdot}7854 \times 31{\cdot}5)$ cubic feet.

= 13,547,471 cubic feet,

= 501,758 cubic yards for excavating.

This at 1 *s.* per yard = 25,088 *l.*

Outer content	-	28,385,177 cubic feet.
Inner ,,	-	25,656,840 ,, ,,
Difference	- -	2,728,337 cubic feet = mass of brickwork.

Dividing by 306 for rods,

We have 8,916 rods, which at 12 *l.* per rod = 106,992 *l.*

	£.
Cost of excavation - - - -	25,088
,, brickwork - - - -	106,992
TOTAL - - - £.	132,080

The arching and support of the roof of the reservoir or reservoirs, puddling and concreting the bottoms, &c., though not specified in the calculation of this estimate, are, in cost, doubtlessly covered by the maximum amount of brickwork employed as datum.

Distributing Mains—(Varying with the Area).

North side sewage per 24 hours = 16,204,320 cubic feet.

Multiplying by ·02841 for tons = 460,364 ·7 tons.

Multiply by 365 for amount per annum = 168,033,115 tons.

At 500 tons per acre this will irrigate 336,066 acres, or 525 square miles. (*See* Appendix, No. 1).

South Side sewage per 24 hours.

= 9,452,520 cubic feet.

= 268,546 tons.

= 98,019,326 tons per annum.

At 500 tons per acre this will irrigate 196,038 acres or 306·2 square miles.

These areas will have to be doubled, for the reason that about one-half only is available for sewage application, the remaining half being roads, towns, &c. The areas, then, for which calculations concerning the mains will have to be made are (instead of 525 square miles and 306·2 square miles) 1,050 square miles and 612·4 square miles for the North side and South side respectively. In order to avoid the country taken up by the metropolis and the river, the areas in both cases are taken as segments of circles as follows:—On the North side the boundary radii are supposed to run due east and south-west, or to form, with the circumference, 5–8ths of the whole circle. From this it is evident the North side area will be portion of a circle whose 5–8th area is 1,050 square miles, and 1–8th area 210 square miles; consequently the whole area is 1,680 square miles.

Letting d = diameter of area.

$$d^2 \times {\cdot}7854 = 1{,}680 \text{ square miles,}$$

$$d^2 = 2139{\cdot}04$$

$$d = \sqrt{2139{\cdot}04}$$

$$= 46{\cdot}2 \text{ miles,}$$

And radius = 23·1 miles.

The south side area will be portion of a circle whose 3–8th area is 612·4 square miles, and the whole area is 1632·8.

As before, d being the diameter,

$$d^2 \times {\cdot}7854 = 1632{\cdot}8 \text{ square miles.}$$

$$d^2 = 2078{\cdot}94.$$

$$d = 45{\cdot}6 \text{ miles.}$$

Radius = 22·8 miles.

From these radii the average fall of the mains per mile in feet may be deduced as $\frac{460}{23{\cdot}1}$ and $\frac{440}{22{\cdot}8} = 20$ very nearly, in each case. Call this H.

The distributing mains are supposed to be so arranged over the country (under the public roads) as to average not greater frequency than one mile of pipe to one square mile of surface of country.* For ascertaining the required diameter of the mains, two hydrants are supposed to be open at once in each square mile. Now, dividing the whole areas into 6, by arcs of concentric circles of 4, 8, 12, 16, and 20 miles radii, it is evident a main traversing the

* *Vide* note (*e.*)

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the first area will have to supply the whole number of openings throughout the entire 23 miles.

Or 23 times 2 openings = 46 openings.
For 2d area 19 × 2 ,, = 38 ,,
,, 3d ,, 15 × 2 ,, = 30 ,,
,, 4th ,, 11 × 2 ,, = 22 ,,
,, 5th ,, 7 × 2 ,, = 14 ,,
,, 6th ,, 3 × 2 ,, = 6 ,,

Each hydrant opening is taken equal to 3 inches diameter, or ·25 feet, and the flow to be 4 miles per hour, or the quantity leaving the main in each area = quantity from each opening × number of openings.

Quantity from each opening
$= \cdot25^2 \times \cdot7854 \times (4 \times 5280 \text{ feet}) \div 60.$
$= 17\cdot28$ cubic feet per minute.

Quantity leaving the mains in the

c. ft.
1st area is 17·28 × 46 (No. of openings) = 795 (very nearly).
2d ,, ,, × 38 ,, = 657 ,,
3d ,, ,, × 30 ,, = 518 ,,
4th ,, ,, × 22 ,, = 380 ,,
5th ,, ,, × 14 ,, = 242 ,,
6th ,, ,, × 6 ,, = 104 ,,

The diameter of the pipes is computed from the formula—

$$D = \frac{2\cdot3\ V^2}{H}$$ ("Hughes on Waterworks.")

V the velocity in feet per second.
D being the diameter of the pipe in feet.
H the inclination of the pipe in feet per mile.

For the first area
Let V = 4·19 feet or 2·86 miles per hour.

Then—

$$D = \frac{2\cdot3 \times 4\cdot19^2}{20}$$
$$= 2\cdot02 \text{ feet.}$$

The flow per minute from this pipe
$= 2\cdot02^2 \times \cdot7854 \times 251\cdot4$ (feet per minute).
= 806 cubic feet.

The required flow is 795 cubic feet; therefore, a 2·02 feet diameter pipe is adapted to the first area.

Resolving the formula similarly for the other areas, we have—

For 2d area a 1·9 feet diameter pipe is required.
,, 3d ,, 1·7 ,, ,,
,, 4th ,, 1·53 ,, ,,
,, 5th ,, 1·29 ,, ,,
,, 6th ,, ·9 ,, ,,

Extent of each area (north side)—
1st area = $\frac{5}{8}$ circle of 4 miles radius.
= $\frac{5}{8}$ × 50·26.
= 31·4 square miles.
2d area = 94·2 ,,
3d ,, = 157·1 ,,
4th ,, = 219·9 ,,
5th ,, = 282·7 ,,
6th ,, = 264·6 ,,

South side—
1st area = $\frac{3}{8}$ circle of 4 miles radius = 18·8 square miles.
2d ,, = 56·5 square miles.
3d ,, = 94·2 ,,
4th ,, = 131·9 ,,
5th ,, = 169·6 ,,
6th ,, = 141·2 ,,

Therefore—Total of
1st areas = 50·2 square miles.
2d ,, = 150·7 ,,
3d ,, = 251·3 ,,
4th ,, = 351·8 ,,
5th ,, = 452·3 ,,
6th ,, = 405·8 ,,

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The 1st area requiring	2·02	feet diameter pipe.
2d ”	1·9	”
3d ”	1·7	”
4th ”	1·53	”
5th ”	1·29	”
6th ”	·9	”

Feet			*Cwt.*	*Qrs.*		*Tons*	
2·02	diameter pipe weighs	(very nearly)	6	2	per yard, or	572	per mile.
1·9	”	”	6	1	”	550	”
1·7	”	”	5	2	”	484	”
1·53	”	”	5	0	”	440	”
1·29	”	”	4	1	”	374	”
·9	”	”	3	0	”	264	”

	Miles		*Feet*		*Tons*	
Therefore	50·2	of	2·02	diameter pipe weighs	28,714	(very nearly).
	150·7	”	1·9	”	82,885	”
	251·3	”	1·7	”	121,678	”
	351·8	”	1·53	”	154,748	”
	452·3	”	1·29	”	169,272	”
	405·8	”	·9	”	107,078	”
				TOTAL - - -	664,375	

	£.
This at 5 *l.* per ton* - - - - - - - - - - =	3,321,875
Average cost of laying, at 5 *s.* per yard (2,925,824 yards) - - =	731,456
TOTAL - - -	4,053,331

* *Vide* note (*f.*)

Contingencies.

All the items in this estimate being calculated in excess of the true amount, no allowance is made for contingencies.

Working the Engines.—(Constant in all Areas.)

The gross HP. as shown is 29,167; $\frac{2}{3}$ of this is considered equivalent to the work to be done = 19,445. The average cost of working each HP. per annum is 15 *l.*—("Hughes on Waterworks.")

Total cost therefore:

$$= 19{,}445 \times 15$$
$$= 291{,}675\ l.$$

Deodorisation.

Dr. Frankland's estimate for cost of deodorisation of the entire sewage for three months is 12,725 *l.*

Cost of applying the disinfectant would about equal this, making total for three months 25,450 *l.*

Salaries and Rent.

Say 15,000 *l.*

Labour expended upon the engines themselves is allowed for in "Cost of Working the Engines."

Recapitulation.

	£.	£.
Cost of Erection:		
Engines and Buildings - - - - - -	1,166,680	
Mains, &c. - - - - - - -	516,571	
Reservoirs and Wells - - - - - -	132,080	
Distributing Mains - - - - - -	4,053,331	
		5,868,662
Cost of Working:		
Working the Engines - - - - - -	291,675	
Deodorisation - - - - - - -	25,450	
Salaries and Rent - - - - - -	15,000	
		332,125
Requisite Capital - - - £.		6,200,787

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Revenue derived from the sale of the sewage, at 2 *d.* per ton,
= (total number of tons × 2) pence
= 266,052,441 × 2.
= 2,217,104 *l.*

This — working expenses = return to the Company
= 1,884,979 *l.*, or 30·4 per cent.

This, with the proposed deduction for the Board of Works, becomes 1,097,540 *l.* or 17·7 per cent. for the Company, and 787,439 *l.* or 12·7 per cent. for the Board of Works.

Notes.

(*a*) If this correction be unnecessary, 47,176 *l.* would be saved in amount estimated for the North Side engines, thus:—

Correction is 29 feet.
∴ HP. = 29 ft. × 716,352 lbs. ÷ 33,000 = 629 HP. (net.)
Gross HP. = $\frac{15}{8}$ of net = 1,179·4
and cost = (1,179·4 × 40) in £.'s = 47,176 *l.*

(*b*) If this correction be unnecessary, 26,548 *l.* would be saved, the amount estimated for South Side engines, thus:—

Correction is 28 feet.
∴ HP. = 28 ft. × 417,760 lbs. ÷ 33,000 = 354 HP. (net.)
Gross HP. = $\frac{15}{8}$ of net = 663·7,
and, cost = (663·7 × 40) in £.'s = 26,548 *l.*

Total gross costs = 73,724 *l.*, averaging 2,587 *l.* per foot of elevation saved in the gross cost = gross cost of 64·7 HP.

(*c*) This is the absolute mechanical force that would be required to overcome the gravity and friction, and include spare power for simply raising the stated amount of sewage the stated height in the stated time. In other words, this power (including reserve) is sufficient to merely lift the sewage, as stated, quite irrespective of the channels through which it is lifted; the only limit to the disposition of pipes or mains being the assumed friction.

(*d*) This is the average rate maintained in the waterworks' systems.

(*e*) This calculation is much in excess of what will be required. Mr. Wicksteed allows only one mile of pipe to 2·8 square miles of country (*see* his Estimate in Appendix, No. 4).

(*f*) Where elevation sufficiently reduces the pressure in the pipes, it is proposed to use the bitumenised paper pipes, these being on an average not more than one-half the price of iron. The elevations not being known, and to as much as possible simplify the calculations, the estimate is based upon the supposition of the mains being iron, and the cost 5*l.* per ton.

APPENDIX, No. 3.

APPENDIX to the REPORT relating to the Main Drainage of the Metropolis, 1857, Sess. 2.

No. 34.—*Cost of Irrigation.*

ESTIMATE of the COST which it would be necessary to incur for the daily distribution of the ordinary daily flow of the Metropolitan Sewage.

	£.
Prime cost of engines, mains, and reservoirs for conveying the sewage an average distance of 15 miles - - - - - - - - -	4,624,500
The formation of 100,000 acres of land into water-meadows at a cost, including distributing mains and watercourses, of - - - - - -	1,200,000
Capitalisation of annual working expenses of foregoing horse-power alone, say 78,200 *l.*, at 20 years' purchase - - - - - - - -	1,564,000
£.	7,406,500

Total cost, 7,406,500 *l.*, or 74 *l.* per acre on 100,000 acres, distributed in 23 separate lots.

In this estimate no provision is made for the daily management required by a system of irrigation so extensive.

No. 35.—*The Craigentinny Meadows.*

"The quantity of water discharged over the lowlying lands in the course of the year must be enormous. I had no opportunity myself of testing the ordinary flow of the Foul Burn, as there was incessant rain during the whole period of my visit; but it has been estimated at 220 cubic feet per minute. The superintendent informed me that it is never allowed to run to waste, except in times of excessive floods. There are not many days in the year in which a greater amount of rain would fall than during my visit, and the irrigation was then proceeding as usual. If it be only assumed, however, that the quantity which comes down in dry weather is applied during nine months of the year, deducting the Sundays as well, there will, on the above calculation, be passed over the meadows annually a depth of water between six and seven feet, and yet the superintendent states that the fertility is invariably in proportion to the quantity of sewage employed.

"The acre = 43,560 feet.

"Assuming a layer of sewage of a height of seven feet upon the acre, the volume of sewage would be 304,920 cubic feet = 8,490 tons.

"100 tons of sewage are worth 17 *s.* 7 *d.*

"8,490 tons, the quantity supplied to the meadows annually, have therefore a value of 74 *l.* 12 *s.*"—*Austin's Reports*, p. 45.

No. 36.—*Reasons of the Failure of the Metropolitan Sewage Manure Company.*

"Considerable works of the most expensive kind were constructed for distributing liquid, very nearly worthless as manure, over a district, obtaining the valuable stable-manure of the metropolis, at the most economical rate, by means of the return-carts which convey to London the produce of the market-gardens, and which would otherwise return empty. In fact, practically, this was little more than a company for supplying the market-gardens of Fulham with water during periods of drought; and, although no doubt a beneficial service, it will readily be imagined that the saving of labour of hand-watering over a limited district of garden ground would produce no adequate return for so costly an establishment."—*Austin's Reports*, p. 74.

APPENDIX, No. 4.

EXTRACTS from the REPORT of *Thomas Wicksteed*, Civil Engineer.

REPORT of *Thomas Wicksteed*, Civil Engineer, "upon the most advantageous mode of dealing with the Sewage-matter of the Metropolis, with a view to the preparation of Sewage Manure."

To the Honourable the Metropolitan Commissioners of Sewers.

40, Coleman-street, City,

Gentlemen,

BEFORE requesting your attention to the Report which you have done me the honour to ask for, I beg leave to call to your recollection the instructions you have favoured me with, conveyed to me in letters and documents received from your Secretary, of which the following are copies:—

No. 1.—A letter from your Secretary, dated 24 November 1853.

"I am directed by the Metropolitan Commissioners of Sewers to inform you that they are engaged in considering the most advantageous mode of dealing with the sewage-matter of the metropolis, with a view to the preparation of sewage manure; and as they are aware you have directed much time and attention to the inquiry, they desire me to ask you whether you would be disposed to favour them professionally with information obtained, in the course of your experience, on the subject which you may deem useful, and if so to propose Tuesday next the 29th instant, at 12 o'clock, at this office for an interview."

In compliance with this request, I attended a meeting of the Commissioners at the time appointed, and was made acquainted generally with the objects they had in view in asking for my opinion, and was requested to confer with Mr. Bazalgette and Mr. Haywood as to the precise instructions and information I should require to enable me to comply with the wishes of the Commissioners. I did so accordingly, and afterwards received the following:—

No. 2.—A letter from your Secretary, dated 8 December 1853.

"I beg to transmit to you, pursuant to the directions of the Metropolitan Commissioners of Sewers, the accompanying copy of the instructions prepared by their engineer, Mr. Bazalgette, and approved by them, from which you will collect the particular points to which the Commissioners are desirous that your attention should be directed in the Report which you are about to prepare for their information. The materials to be supplied to you, as described in the concluding part of the instructions, shall be at once prepared, and supplied to you as soon as they are ready.

"*Instructions for Mr. Wicksteed.*

"That Mr. Wicksteed be requested to report, generally, as to the information obtained in the course of his experience on the subject of dealing with the sewage-matters of towns by converting the same into solid manure, or otherwise disposing of it, and particularly as to the extent of deodorisation and purification of the sewage-water effected by the processes, the actual commercial value of the residual manure, and as to the practicability of constructing sewage-manure works without causing in any degree nuisance in their vicinity.

"That

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"That he be requested specially to report as to the expediency of placing works for the manufacture of the sewage-water into solid manure solely at the outlets of the intercepting sewers proposed for each side of the river, or at intermediate stations, and as to what, in his opinion, would be the maximum and minimum sizes of works, considered in relation to the extent of population, which, in a sanitary and economical point of view, might be established for the manufacture into solid manure of the sewage-waters of the metropolis.

"That he be requested further to report whether, with existing information as to the value of sewage-water, a company would guarantee to the public the conversion of the whole of the metropolitan sewage into manure.

"That, for the purpose of enabling him well to consider the question, he be supplied with a Plan, showing the proposed lines of intercepting sewers, the position and height of the lifts, and information as to the amount of sewage likely to be carried off by them, and also with the situations which suggest themselves as suitable for the establishment of sewage-manure works."

Upon the 17th of December I received from Mr. Bazalgette a map, exhibiting a general view of the main sewers for the Northern Drainage, with the following information from Messrs. Bazalgette and Haywood:—

No. 3.—From Mr. Bazalgette, dated 16 December 1853.

"The main sewers of the Eastern Division are capable of being terminated at the points A, B, and D, at the River Lea, and their contents being separately or collectively manufactured into manure in that locality, or they can be continued so as to discharge at mean highwater at the mouth of the Roding. With this view A and B will be nine feet above Trinity highwater at crossing over the River Lea, and the sewage could possibly be there converted into manure without pumping.

"The main sewers of the Western Division will have two separate flood-outlets into the river, at the points E and I, the inverts being there level with low-water.

"Sewage-manure works could be established at both these points, or the sewers could be connected so as to have one establishment.

"We have taken the sewage at five cubic feet per head, and the Tables give the sewage thus due to the present population, and also due to the ultimate increase of population as estimated by us:—

"NORTHERN SEWAGE INTERCEPTION AND DRAINAGE.

—	Present Population.		Prospective Population.	
	Cubic Feet per Diem.	Cubic Feet per Min.	Cubic Feet per Diem.	Cubic Feet per Min.
Hackney Brook - A.	462,240	321	2,075,040	1,441
Middle Level - - B.	3,911,040	2,716	4,574,880	3,177
Low Level - - - C.	3,225,600	2,240	3,415,680	2,372
Total - D.	7,598,880	5,277	10,065,600	6,990

"WESTERN DIVISION.

—	Present Population.		Prospective Population.	
	Cubic Feet per Diem.	Cubic Feet per Min.	Cubic Feet per Diem.	Cubic Feet per Min.
Acton Line - - E.	169,920	118	662,400	469
Cheyne Walk—Branch to ditto - - - F.	224,640	156	224,640	156
Brentford Line - G.	298,080	207	1,732,320	1,203
Fulham Branch to ditto - - - H.	37,440	26	139,680	97
Total - I.	730,080	507	2,759,040	1,916

"*Memoranda.*—The height of the lift, from the invert of the Low-level Sewer at the pumping station near West Ham Abbey to the invert of the High-level Sewer, is 35 feet; and to Trinity highwater mark 26 feet.

"The height of the lift, from the invert of the sewer at the pumping station in Fulham Meadows to Trinity high-water mark, is 17 feet."

Upon the 22d of December I received a copy of the map of the Southern Drainage, with the published reports of your engineers.

I have much pleasure in acknowledging the facilities that have been afforded by Mr. Bazalgette, your engineer, and Mr. Haywood, the engineer to the City Commissioners of Sewers, by promptly supplying me with the necessary plans and information—an assistance the value of which can only be fully appreciated by those who, like myself, have not unfrequently felt its want.

At the request of the engineers I proposed to make an Appendix to my Report, in which more detailed information will be afforded than could be conveniently introduced into the Report itself.

In the Report, to which I now beg leave to call your attention, I have endeavoured to fulfil the foregoing instructions, as far as practicable.

REPORT.

I am requested to report,—first, generally, as to the information obtained in the course of my experience on the subject of dealing with the sewage-matters of towns by converting the same into solid manure, or otherwise disposing of it.

It will probably be considered useless to adduce any additional evidence to that already obtained, to prove that the sewage water of towns contains much valuable fertilising matter, as the fact that it does so is now, I believe, universally admitted; and that its value is not attributable solely to its containing urine and excrementitious matter in a state of dilution, but also to other ingredients from dye-works and manufactories, producing refuse of animal and vegetable matter, and the ammoniacal refuse from gasworks also adds to its value.

It is well known that urine and excrementitious matter, where it can be collected separately, and properly diluted in farmyard tanks (its strength being proportioned to the crops for which it may be required), is far superior, quantity for quantity, to the contents of town sewers generally; but the sewers of a manufacturing town will contain larger quantities of refuse from manufactories, in proportion to the whole quantity of sewage water, than of refuse from waterclosets.

It is also well known that the application of manure to crops in a liquid form is, in a great many instances, more advantageous than when used in a solid form, especially when applied to green crops. The question, however, of the amount of dilution in the liquid form has either been blinked or has had too little importance attached to it, and thus the term "liquid manure" has been used indiscriminately, not only to represent that collected in farmyard tanks, but also that obtained from the sewers of towns in which, the supply of water being deficient, the dilution has not been great; and, again, to the sewage water of the metropolis and other large towns, where the dilution, as compared with the other two cases, may (not unfairly) be termed excessive, being probably six or seven times greater. But to those unacquainted with such facts, the indiscriminate use of the term creates the idea that all liquid manures are equal in value, and hence the statements that have been published as to the very beneficial results of the application of liquid manure should be received with great caution, however truthful the individual statements may be.

There can be no doubt that the floodwaters supplied from a district the land of which is chiefly arable will produce as much more beneficial effect upon green crops than those from a barren or mining district. In the latter case it may be positively injurious. There can also be no doubt that the beneficial effect produced in the first case arises chiefly from the effect of the waters containing the manure that has been washed off the arable lands during the progress of the flood; and I should imagine there could be as little doubt that the quantum of benefit derived from the application of these waters must, in a great measure, be in proportion to the solid contents of the fertilising matter with which they are impregnated.

It would, therefore, appear evident that any comparison made between the liquid manure used by the German farmers, that used by the proprietors of the Edinburgh Meadows, and others the beneficial results of which have been published, and the sewer water of the metropolis, or that of New York, where the supply of water is now reported to amount to 90 gallons per head per diem, and those large towns in Great Britain where abundant supplies of water are now afforded, could only lead to error, unless the actual amount of solid fertilising matter contained in such water be first ascertained.

Nevertheless, with all this knowledge upon the subject, the difficulty of applying the sewage-water of large towns in a liquid form, so as to produce a commercial benefit, has not been overcome; and the additional experience I have obtained since 1845 induces me to adhere to the opinion I then expressed, namely, that the difficulties are insuperable.

Nevertheless, there are many very intelligent agriculturists who, it may be assumed, from various publications of their opinions, still consider the distribution of the sewage of towns through pipes, by the application of steam-power, as the only legitimate method of disposing of it; but I imagine they have been misled by the publications or advice of engineers as to the practicability, not to say ease, of distributing large quantities of water over a wide extent of surface, and the consequent economy of such a mode of applying it.

It may, perhaps, be as well to consider the principles which necessarily limit the application of this proposed system; and, for the purpose of elucidation, I will suppose the case of a town but very moderately supplied with water, in which the sewage is comparatively strong, but in which the supply of water afterwards becomes abundant, so that there shall be four times the quantity of water passing through the sewers, and thus diluting their contents four times. I will also suppose that a system of mains and services had been laid over a large tract of land in the neighbourhood for the purpose of conveying and distributing the sewage water of the town before the accession of this additional supply of water, that an engine of 100-horse power had been erected for raising and distributing the sewage, that one-tenth of this power had been required to raise the water from the bottom of the sewers to a height of 10 feet above the level of the neighbouring river, and that the remaining nine-tenths (or 90-horse power) had been required partly for overcoming the friction created by the passage of the water through the system of pipeage, and partly to provide for sufficient pressure to distribute the water in jets over the land: that the cost for distributing the comparatively strong sewage water upon this system had been such that the revenue derived from the sale of the sewage water had so far exceeded the working expenses as to make it a profitable undertaking.

Now, as the improved supply of water would gradually increase the quantity of the sewage water to double, treble, or four times the original quantity, the capacity of the mains and works must also be increased, either by adding to the number of engines and mains in proportion to the increased quantity of water, or, if the pipes are not increased in number or size, the steam-power must be increased, first, to lift the increased quantity—and in this instance the increase of power will be in direct proportion to the increase of quantity, or from 10 to 20, 30, or 40-horse power; and, secondly, to overcome the increased friction caused by the larger quantity of water passing through the same pipes: but it is a well-known fact, open to proof in any waterworks in the kingdom, that the power required for this purpose must be increased, not in direct proportion to the quantity, as in the first instance, but in the proportion of the squares of the quantity, or, which is the same thing, as the square of the velocity. The power, therefore, in the second instance would have to be increased from 90 to 360, to 810, or to 1,440-horse power, which latter would be for four times the required quantity, instead of from 10 to 20, 30, and 40-horse power required for merely raising the water a given height without distributing it; and, in my opinion, this principle has been too frequently overlooked, although it may, in fact, limit the application of the system.

But this increase of water involves also a commercial disadvantage, for its value would be reduced in inverse proportion to the cost of distribution; or, in other words, while the capital and annual expenses might have to be increased four times, only the revenue would be reduced to one-fourth, every ton of the increased quantity of sewer water containing only one-fourth of the fertilising matter it originally contained.

There is, however, another point of no mean importance to be taken into account in the consideration of this question; for, supposing a company to be actually formed for the disposal of the sewage in this manner, it will readily be admitted that the interests of the two bodies (the Commissioners on the one hand and the company on the other) should

App. No. 14. should be as nearly as possible identical, that the public might derive the advantages they have a right to claim from such an arrangement: but I think it will appear that, on the contrary, their interests would be antagonistic.

I think it cannot be doubted that the objects sought by the Commissioners, as representatives of the public, would be, first, to dilute the sewage in its passage from the houses and while it remained in the sewers under the town as much as possible, as it is well known that the noxious effect of sewage is much increased by concentration, and to effect this dilution it would, therefore, obviously be a chief object with the Commissioners to encourage an abundant supply of water; and, secondly, that no sewage water shall be discharged into the river of a town unless previously deprived of its noxious qualities. In arranging, therefore, with such a company, the Commissioners would imperatively require that the whole of the sewage water should be removed to a distance from the town as rapidly as it was supplied by the sewers.

On the other hand, it can hardly be doubted that the company would do all that they could to prevent an increased supply of water to the town, simply because their property would be much reduced in value by the greater dilution of the sewage water; and if they could not offer any effectual obstruction to such a proceeding, they would naturally endeavour to lessen their losses, either by avoiding, as far as possible, the erection of additional works, or by conveying a portion only of the sewage water from the town.

The probable result, however, would be that the company would be ruined, and that the Commissioners would have to look out for some other means of disposing of the sewage water.

If the object of this "Report" was solely to enable the Commissioners themselves to arrive at a conclusion as to the best mode of disposing of the sewage water of the metropolis, it would probably be considered that I had already said more than was necessary upon this portion of the subject; but as I am informed that the Commissioners wish to enable others who have not the opportunity of their experience to satisfy themselves as to the feasibility of the plans that have been proposed for the disposal of the sewage water of the metropolis, and as the public are told on the one hand, by unprofessional parties, that the time will come when every railroad will have a large iron tunnel running under or alongside it for the purpose of distributing the sewage water of towns over agricultural districts, while, on the other hand, professional men publish statements of the economic advantages of such a system, based upon imperfect practical experience and data by far too confined to warrant its adoption on a large scale, I may perhaps be permitted to make some further observations before quitting this part of the subject.

To enable me to comply as strictly as possible with your instructions, and as the adoption of any particular plan must at last depend upon its being capable of producing commercially a beneficial effect, I have endeavoured to make an estimate of the cost of conveying the sewer water of the metropolis to, and distributing it over, agricultural districts; and although I have arrived at an estimate which will be sufficiently large, I imagine, to settle the commercial question, I can only consider this amount as a portion of what the ultimate cost might be in carrying out a scheme which, after an examination of the following statement, you will probably agree with me in terming purely chimerical.

The population of the metropolis, according to the last census, amounted to 2,362,236. The increase from 1831 to 1841 was at the rate of 17¾ per cent., and from 1841 to 1851 at the rate of 21¼ per cent.; and supposing the increase in the next 10 years to be at the rate of 20 per cent., in 1861 it will amount to 2,834,683.

From the vast increase in the supply of water which is rapidly taking place, I consider that 36 gallons, or rather more than 5¾ cubic feet per individual per diem, would be a fair amount to estimate upon for the future.

At this rate the daily quantity of sewage water will amount to 102,048,588 gallons per diem, or 166,719,199 tons per annum.

According to the analysis of the eminent chemists, Professor Brande and Mr. John Thomas Cooper, 150 tons of sewer water from King's Scholars' Pond Sewer contained $\frac{1}{500}$th part or 6 cwt. of solid matter, which may be considered a sufficient average quantity for an acre of ground per annum. The solid matter contained in 166,719,190 tons of sewer water will, therefore, be equal to 6,668,760 cwt., which, at 6 cwt. per acre, will supply an area of 1,111,460 acres.

The extent of district to consume this quantity will be rather more than double, or 3,500 square miles, equal to a circle of 66½ miles in diameter; the main pipeage required will be equal to 1,236 miles, varying in diameter from 38 inches to 12 inches.

The steam-power required will be equal to 16,152 horses, working under a pressure equal to a column of water 500 feet.

The capital required will amount to nearly 12,000,000 *l.* sterling.

The quantity of coals required per annum will be about 170,000 tons.

The annual cost for coals, labour, stores, and repairs for engines and buildings, will amount to about 240,000 *l.* sterling.

Supposing 10 per cent. upon the capital to be sufficient to cover all disbursements, including 5 or 6 per cent. interest upon the capital, this will amount to 1,200,000 *l.* per annum, which for 333,438 tons of solid matter (*vide* Appendix) will give a cost of 3 *l.* 11 *s.* 9 *d.* per ton.

A detailed calculation will be given in the Appendix, but the foregoing will perhaps be sufficient to convince the Commissioners that the liquid scheme, even if it could be carried out as herein proposed, is not a feasible one: but when, in addition to what has been stated, it is borne in mind that the basis upon which the calculation rests is upon the assumption, 1st, that the whole of the sewage water could be collected in one central spot; 2dly, that 12 38-inch radial pipes could be laid in straight lines from the central point; 3dly, that the circle of 66½ miles in diameter round the metropolis is a flat plain, and that the Surrey hills on the south and the Middlesex and Hertfordshire hills on the north do not exist; 4thly, that a sufficient number of landed proprietors could be found within the proposed extent of district to use so large a quantity of one kind of manure, and, as the supply must be constant, to construct covered reservoirs on their lands to hold the supply during such periods as it is not being actually poured upon the land (and unless these, to me, impossible conditions can be complied with, the estimate for 12,000,000 *l.* will be found much too small), I think the Commissioners will agree with me that such a scheme for the disposal of the sewage water of the metropolis should not be entertained.

Having years ago, as before mentioned, formed the opinion that however valuable the application of liquid manure to land might be, and however economically and profitably it might be supplied on a small scale, that upon the large scale it was in effect commercially impracticable, I turned my attention to the application of it in a different form; and I will now proceed to give the Commissioners such information as my experience enables me to do, as to the feasibility of extracting from the sewage water fertilising matter in a solid form.

The real difficulty that has existed with reference to most of the schemes proposed for the disposal of the sewage has been that of dealing with large quantities. A scheme may be a good one, and based upon right principles, and may be carried out effectually and profitably upon the small scale; but, as has been shown in the case of the liquid scheme, the difficulties that present themselves to carrying it out upon the large scale are frequently insuperable, and a scheme that might answer remarkably well for each of a hundred small towns would be commercially impracticable if applied to one town having a population equal to the aggregate population of the hundred small towns: for example, the plan that has been proposed for filtering sewer water through a charcoal medium would be good, inasmuch as the charcoal would absorb a great deal of fertilising matter, and is at the same time a good deodorant. Now, taking a population of 5,000, and assuming the supply of sewer water to be equal to 36 gallons per head per diem, or 5,776 cubic feet, this would be equal to 180,000 gallons per diem; and supposing three-fourths of this to be supplied in 12 hours of the day, it would be equal to 135,000, or 187½ gallons per minute. Now, for the perfect filtration of ordinary river water, such as the Thames or the Lea, it requires two square yards of filtering surface to clear one gallon per minute; but for extraordinary water, such as is found in the River Clyde in certain seasons of the year, and which is discoloured by vegetable matter, it requires 5½ square yards of filtering surface to render the water colourless; but taking the two square yards as being sufficient for the sewage, it would require a filtering bed of 375 square yards, or rather less than one-twelfth of an acre, to clear this quantity of water. Such would be the size for a small town; but taking the metropolis, as before estimated, at 17,057 cubic feet, or 106,299 gallons per minute, it would require a filter bed of 44 acres area, or 1,383 feet square. Such a plan therefore, supposing it to be in other respects eligible, however suitable for a small town, would probably be deemed inapplicable to the metropolis.

It would, perhaps, be readily admitted that any plan proposed for the disposal of the sewage of the metropolis, or any other town, should be subject to two conditions—first, that the sewage water, before exposure to the open air, should be thoroughly disinfected; and, secondly, that the residue or noxious matter which is taken from it would not only be converted into a source of profit, but that the operations required to produce this conversion should be such that no nuisance may arise therefrom in the neighbourhood.

If the water is merely deodorised, and the precipitate matter is left to accumulate, it will not only require reservoirs of very great area, but when the supernatant water is drawn off, and the mud at the bottom has to be removed, as it must be periodically, its removal will not only be expensive but, from the large extent of surface that must necessarily be exposed, it might become a source of serious nuisance, at the same time that the separation of those gases which exhale and cause the nuisance would reduce, *pro tanto*, the fertilising value of the deposit. Hence it is obvious that such reservoirs would have to be constructed at a considerable distance from the habitable portions of the metropolis.

But when, in 1845, I proposed to construct similar reservoirs at Barking Creek and the Greenwich Marshes, my object in proposing outfalls so distant from the metropolis was rather with a view of conciliating the then popular prejudices than from a belief that the works themselves, if brought any nearer to London, would have been in any way prejudicial to the surrounding neighbourhood, for I had at that time ascertained the effect of the action of lime upon sewer water, and finding that the water was completely deodorised, I assumed that the precipitate would be equally so; but subsequent experience has proved to me that when large surfaces of the wet mud at the bottom of a reservoir are exposed, by the removal of the supernatant liquor, the smell arising from it is unpleasant, although I believe perfectly innoxious; and as this smell is produced by the evaporation of the fertilising ingredients, as before observed, it became an all-important matter, in a commercial point of view, to avoid unnecessary exposure, and I believe by the process I now adopt, and which will be explained hereinafter, the object has been fully attained.

[Here follow the details of Mr. Wicksteed's plan for extracting the manure from the sewage by his patent lime process]:—

"Disposal of the Sewage-matter of the Metropolis Liquid Scheme.

"*Quantity of Sewage Water.*

"Taking the amount of sewage water at 36 gallons per head per diem, which will be the quantity at ordinary periods, exclusive of floods, and the population in 1851 being, according to the census, 2,362,236, and supposing the increase to be at the rate of 20 per cent. in 10 years (from 1831 to 1841 it was 17¾ per cent.; from 1841 to 1851 it was 21¼ per cent.), then in 1861 it will amount to 2,834,683.

"The sewage water will then amount to—
102,048,588 gallons per diem, or
2,834,683 barrels per diem, or
16,374,935 cubic feet per diem—and to
1,034,659,295 barrels per annum, or
166,719,190 tons per annum.

"*Quantity*

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" *Quantity per Acre.*

" The late Mr. Smith, of Deanston, calculated that from 80 to 160 tons of sewage water per annum per acre might be usefully applied to the land, upon an average of arable and pasture, or in some instances more.

" An average of 150 tons per annum per acre may therefore be taken as the quantity to be applied: and as the solid contents of the average sewage water from King's Scholars' Pond Sewer, as analysed by Professor Brande and Mr. John Thomas Cooper, the eminent chemists, was equal to 1-500th part, every 150 tons will contain six cwt. of solid manure.

" *Acreage required to consume the whole of the Metropolitan Sewage Water.*

" The annual amount of sewage water being equal to - - -	166,719,190 tons,
" One five-hundredth part will amount to - - - - - -	333,438 tons, or 6,668,760 cwt.
" Which divided by 6 cwt. per acre will give us the required acreage -	1,111,460 acres.

" *Extent of District to consume the Sewage Water.*

" Suppose, under the most favourable circumstances, all the sewage of the metropolis could be collected in one central spot, then, as no appreciable quantity would be likely to be used in the metropolis, a radius of three miles at least must be passed through before any of the sewage could be used—equal in area to 28 square miles.

" Then the area of roads, towns, villages, plantations, and woods must be excluded from the effective area of the proposed district; and as it is not likely that much more than half the estates to be supplied would use 150 tons per acre, nor is it probable that any one manure will entirely supersede the use of another, the district to be supplied must be at least double the acreage capable of being supplied by the manure—equal 2,222,920 acres, or 3,473 square miles, which added to the 28 square miles makes the required district equal to 3,501 square miles, or a circle of 66·8 miles diameter, and a radius of 33·4 miles.

" *Size of Main Pipes required to distribute the Sewage Water.*

" The water will have to be raised and distributed as fast as the sewers supply it, and probably about 7-8ths of the whole quantity is supplied during 12 hours in the day; but I shall assume only 3-4ths for the basis of my calculation:—

Quantity per diem - - - -	102,048,588 gallons, or 16,374,934 cubic feet.
Quantity per 12 hours, or 3-4ths - -	18,281,200 cubic feet, or 17,057 cubic feet per minute.

" Taking the velocity of the water at 180 feet per minute, the area of a pipe to convey the quantity of water would require to be equal to 95 square feet, or 11 feet diameter, or 12 pipes each of 38 inches diameter.

" Now, dividing the total effective area into 4, there will be 868¼ square miles for each, but to the first district 28 square miles must be added, making the first area equal to 896¼ square miles, equal to a radius of - - - - - - - - 16·8 miles of 38-inch pipe—16·8 miles.

2d area, 1,764½ square miles	=	to a radius of	-	23·6	"	33-inch	"	6·8 "
3d do. 2,632¾ "	=	"	-	28·9	"	27-inch	"	5·3 "
4th do. 3,501 "	=	"	-	33·4	"	19-inch	"	4·5 "
								33·4 "

" *Length of Main Pipes.*

12 pipes of	38 inches diameter,	each	16·8 miles long,	-	201·6 miles.
12 "	33 "		6·8 "	-	81·6 "
12 "	27 "		5·3 "	-	63·6 "
12 "	19 "		4·5 "	-	54·0 "

" Divide this circle into 8 spaces inclosed by 7 concentric circles of mains, and suppose pipes averaging 12 inches diameter to be thus laid, connecting the 12 radial pipes, then the length of the 12-inch pipes will be as follows:—

1st circle,	14 miles diameter,	or 43·98	miles in circumference.
2d do.	22 "	or 69·11	"
3d do.	30 "	or 94·24	"
4th do.	38 "	or 119·30	"
5th do.	46 "	or 144·50	"
6th do.	54 "	or 169·60	"
7th do.	62 "	or 194·70	"
		835·43	miles of 12-inch pipe.

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" *Estimate for Mains.*

miles.		*yards.*	*in.*	*tons.*		*tons.*		
201·6	or	354,816	of 38	dia. at 68 1/8	per 100 yards	241,707 at £8. =	£. 1,933,656	
81·6	or	143,816	of 33	„ at 53 2/10	„	76,395 at „ =	611,160	
63·6	or	111,936	of 27	„ at 37 8/10	„	42,298 at „ =	338,384	
54·0	or	95,040	of 21	„ at 21	„	19,950 at „ =	159,600	
835·4	or	1,470,304	of 10 1/8	„ at 10 1/8	„	148,868 at „ =	1,190,944	
								4,233,744
1,236·2								

" *Laying and Joining.*

354,816 yards of 38 inches, at 22 *s.* - - - -	£. 390,297	
143,616 „ of 33 „ at 17 *s.* - - - -	122,073	
111,936 „ of 27 „ at 11 *s.* 6 *d.* - - - -	64,363	
95,040 „ of 19 „ at 7 *s.* - - -	33,264	
1,470,304 „ of 12 „ at 3 *s.* 3 *d.* - - - -	238,924	
		848,921
		£. 5,082,665

" *Friction.*

Inches.	*Yards.*	Velocity. *Feet.*	Head p' 100 Yds. *Inches.*		*Feet.*
38	29,568	180	581	$= \frac{295·68 \times 5·81}{12} =$	143·15
33	11,986	„	6·69	$= \frac{119·68 \times 6·69}{12} =$	66·72
27	9,328	180	8·18	$= \frac{93·28 \times 8·18}{12} =$	63·58
18	7,920	„	11·63	$= \frac{79·20 \times 11·63}{12} =$	76·75

Friction - - - - -	350·0
Head for Distribution - -	150·0
Pressure - - - -	500·0

" *Engine Power.*

" $\frac{\text{17,057 cubic feet per minute} \times \text{500 feet}}{528}$ = 16,152 horses-power, or 80 engines of 200 horses-power each, and allowing one-tenth for spare power, or one extra engine to every eight, will make the total required 88 engines, or 17,767 horses-power.

" Taking the engines and boilers, engine and boiler houses, chimneys, coal bins, &c., at 100 *l.* per horse-power.

" Engines, &c., 17,767 horses-power, at 100 *l.* - - - - - - - £. 1,776,700.

" Taking the cost of distributing pipes and tanks for holding the liquid sewage when it cannot be applied at 3 *l.* per acre, 1,111,460 acres at 3 *l.* - - - - - - - - £. 3,334,350.

" *Summary.*

	£.
" Engine-power and buildings - - - - - - - -	1,776,700
Mains and laying - - - - - - - - -	5,082,665
Distributing pipes, &c., upon farms - - - - - -	3,334,380
Add 15 per cent. for contingencies - - - - - -	1,529,301
TOTAL - - - £.	11,723,046

" Or 10 *l.* 11 *s.* per acre; or 35 *l.* 3 *s.* 2 *d.* per ton of solid; or 16 ¾ *d.* per ton of liquid; or 82 *s.* 8 ½ *d.* per inhabitant.

" *Coals required per Annum.*

" Average power equal to - - - - - - - - - - 16,152 horses.

" Coals per hour per horse-power - - - - - - - 2 ¾ lb.

being the average quantity used by the Wicksteed engine at the East London Waterworks in 1849.

" Engines working 24 hours, 365 days, will consume per annum - - - - 173,700 tons.

" Cost of coals, stores, labour and repairs of engines and buildings, taken at 15 *l.* per annum per horse-power.

" Annual cost for 16,152 horses-power, at 15 *l.* - - - - - - £. 242,280.

" *Probable*

" *Probable Cost of Manure to make it remunerative.*

" Supposing 10 per cent. upon the capital to cover all disbursements and yield a sufficient profit, this will amount to 1,200,000 *l.* per annum.

" The sewage water, as before calculated, amounts to 166,719,190 tons per annum.

$\frac{166,719,190}{1,200,000}$ = to nearly 139 tons for 1 *l.* sterling, or 1·72 *d.* per ton.

" The amount of solid manure, as before stated, is equal to 333,438 tons.

$\frac{1,200,000}{333,438}$ = to 3 *l.* 11 *s.* 9 *d.* per ton.

" Although I state, in the body of the Report, that the execution of such work as the one herein estimated for, is totally impracticable in the neighbourhood of the metropolis, these calculations will at least furnish the data upon which such estimates ought to be formed for localities suitable for such works.

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11 A, Hart-street, Bloomsbury-square,
Sir, 13 January 1862.

I BEG to forward you for publication, with the other documents received by your Board in connection with the sewage, my letter of the 31st December last, in answer to your communication of the 16th November, delivered at the Board of Works on the 6th instant.

You will perceive that certain unavoidable typographical errors are corrected.

The amendments proposed and carried by Mr. Doulton, in opposition to the resolution of Mr. Wilkinson, necessitates this course.

I have, &c.
John Pollard, Esq. *Thomas Ellis.*

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11 A, Hart-street, Bloomsbury-square,
Sir, 11 February 1862.

MR. NAPIER's plan for utilising the sewage of the north side of the metropolis, having, so far as I can learn, been the only plan for dealing with the sewage referred to Mr. Bazalgette to report upon, and certainly the only one reported on by him to the Main Drainage Committee, notwithstanding my having several months previously sent you all necessary details, as to my plan for distributing by gravitation the entire sewage of the metropolis, I beg respectfully to protest against a concession of any portion of the sewage being granted to Mr. Napier.

Mr. Napier's plan, and the estimates in support of it, having been referred by the Main Drainage Committee to Mr. Bazalgette to consider, that gentleman made his report to the Committee in favour of Mr. Napier's plan and estimates, to the effect that " the works were carefully considered and well designed, and the estimates fair and sufficient"; and, " so far as the engineering character and details are concerned, it is thoroughly practical, and deserves the favourable consideration of the Board."

The Main Drainage Committee basing their opinion (as was but natural) upon Mr. Bazalgette's examination, and his very decided approval of Mr. Napier's plan and estimates, reported to their Board in favour of granting a concession of the sewage of the north side of the metropolis to Messrs. Napier & Hope; but it will be in the recollection of the Board that, on the 10th of January, when the proposed concession was last under discussion, it was elicited from Mr. Bazalgette that his Report to the Main Drainage Committee had been made without any personal examination of the localities to be operated on, he not having been in that part of the country for 12 or 14 years.

Mr. Bazalgette's admissions, of course, destroy his report, and all reports and proceedings based, as the Report of the Main Drainage Committee was, on Mr. Bazalgette's report, fall of necessity with his, and the entire question is re-opened.

The danger of proceeding to act upon Mr. Bazalgette's report will be at once evident, when it is recollected that one of the items in Mr. Napier's estimate, which Mr. Bazalgette reports on as " well considered," and the cost " fair and sufficient," is 500,000 *l.* for 26 miles of a sea embankment, which, upon examination, is found could not be built for less than 20,000,000 as it is to be constructed on a quicksand not less than 40 feet deep.

It may be said that these are questions for a Committee of the House of Commons, and that that is the proper place for their examination. That would be true, if Mr. Napier went in the first place to Parliament for his Bill, without coming to the Metropolitan Board of Works for a concession of the sewage.

By granting that concession the Board would, in effect, say to Parliament and to the public, " We have by our engineer, by our Main Drainage Committee, and by our full Board, carefully considered Mr. Napier's plan, and his estimate in support of it, to which we give our entire approval. Besides, the Committee before whom Mr. Napier's Bill would be sent, would have simply to hear evidence for and against that particular plan, and none other, and every one knows that the cost attendant upon opposing a Bill before Parliament is enormous, and it could not be expected that any private individual would undertake such a task." Hence, Mr. Napier's Bill, sanctioned by your Board, would be considered as an unopposed Bill, and without any difficulty pass through its various stages in Committee.

In conclusion, I wish to be permitted to call the attention of the Board to a point upon which I fear I have been misunderstood. It having been asserted by Mr. Thomas Wicksteed, in 1852, when he had a scheme before the public for extracting the manure from the sewage by his patent lime process, that it was " a commercial impossibility to utilise the sewage of the metropolis in its fluid state, on account of the great cost of the necessary works, I furnished to you," in order to meet Mr. Wicksteed's assertion, a detailed estimate of the cost of my work, amounting to 5,868,662*l.*, which, together with the working capital, made a total of 6,200,787*l.*, upon which, selling the sewage at 2*d.* per ton, I showed a return of over 30*l.* per cent. after deducting working expenses. But I explained at the time, and repeatedly since then, that this estimate was made purposely in excess simply to meet Mr. Thomas Wicksteed's assertion, and that my true working estimate would be much less, showing, of course, a greater return to the shareholders and to the ratepayers. These explanations seem to have been lost sight of, and my scheme treated as visionary, on account of the great cost of the works. In justice, therefore, to myself, I wish to be allowed to inform the Board that my working estimate will not exceed three millions, and that my working expenses will be so small in comparison with the mass of sewage to be dealt with, that I shall be able to deliver one ton of sewage anywhere upon my area at a cost to my company of less than one farthing. From this it is easy to see that there will be dividend of over 60*l.* per cent. on the outlay, to be divided between the Metropolitan Board of Works and my company, which will place at the disposal of the Board, for the reduction of taxation, or for necessary local improvements, an annual sum of not less than 700,000 *l.*, provided the main sewers now being constructed are capable, as I presume they will be, of conducting to the outfall tanks the present amount of diluted sewage; for, if so, there will be found annually, at the outfall tanks, not less than 266,052,441 tons, which, at 2*d.* per ton, is worth 2,217,104*l.*

Those who scoff at my calculations, or who urge the giving away to Mr. Napier as worthless the greater part of this vast amount of valuable property, should be prepared to prove two things; first, that the main sewers are failures, not capable of dealing even with the present amount of sewage; and, secondly, that the magnificent analysis and computations of Hoffman & Witt, determining the value of the diluted London sewage at 2*d.* per ton, are erroneous.

I have to request that you will lay this letter before your Board on Friday next, previously to the reopening the adjourned debate on the proposition to grant a concession of the sewage of the north side to Messrs. Napier and Hope.

I am, &c.
(signed) *Thomas Ellis.*

To the Chairman of the
Metropolitan Board of Works.

Sir, 18 February 1862.

At the meeting of the Metropolitan Board of Works held on Friday last, the subject of the several propositions for taking the sewage of London was brought under the notice of the members, and I laid before them your letter of the 11th instant, with reference to the proposed concession of the northern sewage to Messrs. Napier & Hope, but the attention of the Board having been called to the fact of the intention of Government to acquiesce in the appointment of a Committee of the House of Commons to inquire into the best means of utilising the sewage of the cities and towns of England, with a view to the reduction of local taxation, and the benefit of agriculture, they adjourned the further consideration of the matter until that Committee shall have made their report.

I am, &c.
(signed) *John Pollard,*
Clerk of the Board.

Thomas Ellis, Esq.,
11A, Hart-street, Bloomsbury-square, W.C.

76, Warwick-square, Belgravia,
Sir, 12 January 1863.

The final Report of the Select Committee of the House of Commons on Sewage of Towns being now published, I beg leave to renew my application for a conditional concession of the sewage of the metropolis on the terms already specified and recapitulated at p. 24 of my letter of the 31st December 1861, addressed to you as Chairman of the Metropolitan Board of Works, in reply to an official letter from the Board, bearing date the 16th November 1861; or upon such modifications of those terms as shall be mutually agreed on.

In that letter I gave minute details of my plan, and pointed attention to the proper method of sewage utilisation, viz., a distribution of it over large areas, and applied in moderation to all description of crops, the sewage to be always under the control of those using it. I explained the benefits that would result from that system to the ratepayers, to agriculture, and to the nation, and contrasted them with the results to be obtained by the system of enormous dressings, proving that if the interests of the ratepayers or of agriculture were to be considered, it would be necessary to adopt the large area with moderate dressings applied to all descriptions of crops, and that we should treat sewage as we now do any other manure which we purchase, that is, that we should apply it to our crops only in such quantities as would insure us a commercial return.

The result of the enquiry of the Select Committee on Sewage of Towns has most conclusively proved the correctness of my theory.

On referring to the "Analysis of the Evidence," which forms a part of their Report, it will be found reported as follows:—

"The evidence further proves, that in the case of Lord Essex, Mr. Westwood, the late farm bailiff of the schools at Annerley, and Mr. Philip W. S. Miles, results have been obtained by small applications of sewage which solve the question of sewage utilisation, showing that if commercial results are to be sought for, results which will enable the agriculturist to pay a fair price for the sewage, and thus yield a return to the ratepayers of our cities and towns from its sale, sewage must be treated like any other manure, and applied to the soil or the crop according to their requirements, bearing in view the returns to be obtained." And further on it is stated—

"Mr. Westwood shows a gross return of 9*d.* for each ton of sewage applied on that portion of Italian rye-grass dressed at the rate of 1,500 tons of sewage per annum, a profit which as well as that obtained by Lord Essex on his wheat crop and meadow grass, and by Mr. Miles, the value of whose land was doubled, would enable them and all those who would use sewage in moderation to pay to those furnishing it such a price as would speedily lead to its general utilisation.

And further on the Committee state—

"In seeking for the solution of the sewage problem it is not necessary to produce a mass of evidence to prove that, by a careful and judicious application of sewage, satisfactory and profitable results will be obtained; one such case is quite sufficient, for what has once been done may be repeated *ad infinitum*.

"Lord Essex, Mr. Miles, and Mr. Westwood have, by the application of comparatively small quantities of sewage, obtained large and remunerative returns in crops, from the profits of which they would have been able to pay largely for the sewage used; and the evidence which this Committee has received fully establishes the fact that when large quantities of sewage have been applied, although a great amount of produce has been obtained, yet that it would have been impossible to have paid for the sewage together with the other charges, and left a profit on the transaction. This Committee are, therefore, of opinion that the evidence which has been given fully establishes the fact that sewage is applicable to all crops, and that if commercial results are to be sought for, it should be applied in small dressings."

The estimates for works, as set forth in my letter of 31st December 1861, and which had been furnished to you for the information of the Board some months previously, are enormously in excess, but they were made so purposely, as explained in that letter, lest I might be charged with making "fancy estimates," in order to show a great profit upon the speculation.

In illustration of this I would direct your attention to the item for engines and buildings, for both sides of the river, which is given at 1,166,680 *l.*, as I made my calculations to pump the sewage on the north side to a height of 460 feet, and on the south side to 440 feet, assuming that it would be necessary to pump to the top of Hampstead and Shooter's Hill, allowing also for corrections for wells and tanks. The exact height which it will be necessary to lift the sewage cannot, of course, be stated until expensive surveys of the entire area have first been made, but it is believed that 200 feet will give us a sufficient elevation; thus more than half the expense for engines will be saved.

And here I would wish to call your marked attention to an objection to my plan which I understand is now made, to the effect that I would cause a nuisance at Hampstead, but fortunately for me and the heavily taxed ratepayers, this objection, like all the rest, is very easily disposed of, for nature, as if for the very purpose of helping us out of the difficulty, has placed on either side of the Thames several hills, not alone isolated hills, such as Hampstead and Shooter's Hill, but also extensive tracts of high ground such as we find in Epping and Hainault Forests, on the north side, from any one of which we can command areas of much greater extent than would enable us to utilise safely and profitably, by gravitation, all the sewage which the Metropolitan Board of Works could ever deliver to us.

And to do away at once and for ever with all such trivial objections to the details of my plan, I am prepared to accept a conditional concession of the sewage, subject to my satisfying the Metropolitan Board of Works that the high grounds, which shall be selected upon which to erect, on either side of the Thames, my regulating reservoir, shall be so situated as to give no cause of complaint to the public.

With respect to the cost of my distributing mains, I charge myself with one mile of main for each square mile of country, which is greatly in excess of what will be required, but the exact amount cannot, however, be known until a survey of the roads of my area be first made. I may, however, here remark that Mr. Thomas Wicksteed, C.E., in his Report to the Commissioners of Sewers, which I have examined in my letter of the 31st December 1861, and whose object was apparently to heap up expenses, so as to show that it would be a "commercial impossibility" to utilise the sewage in the liquid state, and who was, therefore, not likely to understate the quantity of mains necessary, puts it at one mile of main to 2·8 square miles of country, or nearly three times less than I have given; this, I think, is a clear proof that I have much overstated the quantity that will be required. In fact, when the true estimates come to be worked out, which cannot, however, be done until extensive surveys of the entire area be first made (which great expense cannot of course be undertaken until some definite arrangement is first entered into between the Board and the party incurring that expense), it will be found that the works can be executed for three millions sterling, or probably less; but, on my present excessive estimate, I show a clear profit, after deducting working expenses, of 30·4 per cent., selling the sewage at 2 *d.* per ton, which it will now, I trust, be admitted is far beneath its real value.

As my letter of the 31st December 1861 has not yet been taken into consideration by the Board, may I venture to hope that they will now be pleased to do so.

I also forward with this, for the information of the Board, an estimate made by my friend Mr. Samuel Hughes, C. E., of Westminster, than whom there is no one in the kingdom stands higher as an authority upon hydraulic engineering.

Mr. Hughes informs me that I have based my calculations upon too large a quantity of sewage, and has made his for a smaller quantity.

His estimate amounts to 4,445,320 *l.*, and on this estimate he shows a return of 15·1 per cent., selling the sewage at 1 *d.* per ton, but that price is of course far below its real value; and his estimates, as well as mine, are excessive, inasmuch as following my plan he allows one mile of distributing main to one square mile of country, and charges, in all cases, a very high price, basing his estimates entirely on iron pipes, whereas I am of opinion that upon the high levels, where the internal pressure upon the pipes will not be great, good stoneware pipes might with advantage be substituted, thus greatly reducing the cost of this item.

Since Mr. Hughes has ceased to be a member of your Board, he has consented to act as engineer to my company, and I have therefore to request that he may be heard before your Board in support of my plan and his estimates, should such an examination be thought necessary; but, as my plan, which, as appears from the Report of the Select Committee on Sewage of Towns, is the true solution of the sewage problem, has now for two years been before your Board, and as such an examination must cause great additional delay, a delay which will render it utterly impossible to proceed to Parliament for another year for powers, a delay which, in postponing the commencement of my works, would cause a loss to the ratepayers of at least 12,000 *l.* per week, and probably a much larger sum, that otherwise, under the agreement which I have had the honour to propose to your Board, as to a division of profits they would receive, I would hope that the Board, now that the agricultural and commercial value of sewage has been clearly established by the evidence taken by the Select Committee, as appears from their Report, would not consider such an examination necessary or advisable, but would refer it to a Committee of the House of Commons, and would proceed at once to a consideration of the terms suggested by me for a conditional concession of the sewage. And here, I may remark, that if the conditional concession of the sewage, for which I now ask, be granted, it will supersede the necessity of the Board carrying out the proposed plan of pouring the sewage of the western district into the Thames at Cremorne, as I shall take the necessary means for its profitable utilisation.

The interest which the Government, the press, and the leaders of public opinion, now take in the great national question of an economic and profitable utilisation of town sewage, of stopping the frightful drain upon the national wealth from which we are now suffering, induces me to believe that every facility will be afforded me in bringing this great question before the country, and that the Standing Orders of the House of Commons would be waived in my favour; but to enable me to make such an application, it is necessary that the Metropolitan Board of Works should first grant me the conditional concession for which I have asked, and that they should do so at once as to enable me to go this year to Parliament (assuming that the Standing Orders would be waived) immense and costly labours will have immediately to be undertaken, which could not possibly be completed in time if any further delay is permitted.

For the above reasons I venture respectfully to press upon the Board the necessity for a prompt decision on my application, trusting that the public spirit which has always been shown by the Metropolitan Board of Works will induce them now, upon national as well as local grounds, to aid me by their co-operation, and to stamp my past labours in this great cause with the seal of their approval.

I am, &c.
(signed) *Thomas Ellis.*

To the Chairman of the
Metropolitan Board of Works.

ESTIMATE for raising and distributing the SEWAGE of the METROPOLIS.

North Side.—The population provided for in the Main Drainage Scheme, exclusive of the western district, is 2,056,800.

Sewage at 5 feet per head, 10,284,000 cubic feet per day, or $\frac{10,284,000}{1,440} = 7,138$ cubic feet per minute.

South Side.—Population provided for 1,149,600.

Sewage at 5 feet per head, 5,748,000 cubic feet, $\frac{5,748,000}{1,440} = 3,990$ cubic feet per minute.

Rainfall.

North Side.—Area provided for, exclusive of western district, 13,164 acres. Then, allowing 18 inches of rainfall annually over this area to reach the outfall reservoir, we have $\frac{4,840 \,.\, a \times 9 \times 1\frac{1}{2}}{365 \times 1,440} = \frac{a}{8}$. Hence the area in acres must be divided by 8 to find the cubic feet per minute, then $\frac{13,164}{8} = 1,645$ feet per minute.

South Side.—Area provided for, 18,116 acres $\div$ 8 = 2,264 cubic feet.

Amounts Collected.

Sewage - -	North side - -	7,138	
	South side - -	3,990	
			11,128 cubic feet per minute.
Rainfall - -	North side - -	1,645	
	South side - -	2,264	
			3,909 - - ditto.
	TOTAL - -		15,037 - - ditto.

15,037 × 1,440 = 21,653,280 cubic feet per day = 219,540,000 tons a year.

Total horse-power required for each foot of lift $\frac{15,037}{528} = 28\cdot48$, say 28½ HP. for each foot of lift.

Take this at 100 *l.* per net horse-power—

		£.
Then, cost for 100 feet	- - - - - - - -	284,800
Ditto 200	- - - - - - - -	569,600
Ditto 300	- - - - - - - -	854,400
Ditto 400	- - - - - - - -	1,139,200
Ditto 500	- - - - - - - -	1,424,000

Pumping mains, 6 miles long; quantity per minute, 15,037 cubic feet $\div$ 180 = 83·5 feet; area of mains $\frac{83\cdot5}{15\cdot9} = 5\cdot3$ mains of 4 feet 6 inches in diameter.

Say, 6 mains, each of which will cost, when laid complete, 8 *l.* per yard run, or 14,080 *l.* per mile.

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Then, 14,080 × 6 mains × 6 miles = 506,880 *l.*

Reservoirs to hold 22,000,000 cubic feet, at 4 *l.* per 1,000 gallons, or 25,000 *l.* per million feet.

22 at 25,000 *l.* - - - - - - - - - - 550,000 *l.*

Distributing mains for 219,000,000 tons covering an area = 1 acre for 250 tons, $\frac{219540000}{250}$ = 878,160 acres or $\frac{878160}{640}$ = 1,372 square miles.

Assume distributing pipes = 1 mile of pipe in length for each square mile of area and take average diameter = 12 inches, such a pipe will cost, with laying complete, 1 *l.* a yard, then 1,372 at 1,760 *l.* = 2,414,720 *l.*

Working Expenses.

	£.
Lift of 100 feet will require 2,848 HP.; then 2,848 HP. at 20 *l.*, including wages of engineers, stokers, labourers, coals, stores, wear, tear, &c. - - - - - -	56,960

General Expenses :—	£.
Directors - - - - - - - -	2,000
Secretary - - - - - - - -	1,500
Engineer - - - - - - - -	1,500
Engineer Assistants - - - - - -	2,000
Two Chief Clerks - - - - - -	1,000
Six Assistants - - - - - - -	1,200
Collectors - - - - - - - -	2,000
Stationery and Office Expenses - - - -	1,500
	£. 12,700

	£.	£.	£.
But in order to cover bad debts and bring the charges up to those on railways, having about equal revenue with proposed company, take 2½ per cent. on revenue of 914,750 *l.*	- -	22,869	
Parochial rates and taxes at 20*s.* - - - - - -	- -	18,295	
Wages: 10 men at Reservoirs - - - - -	600	- -	
Foreman ditto - - - - - -	100	- -	
Turncocks and men attending distributing pipes, one man to two square miles: 686 at 60 *l.* - - - - - - - - -	41,160	- -	
		41,860	
70 Foremen and Clerks of Works at 150 *l.* - - - - -		10,500	
Repairs and restoration of works and mains (engines and pumps already provided for) at 1 per cent. - - - - - - - - -		34,716	
			128,240

For 100 feet - - - - -	185,200
„ 200 ditto - - - - -	242,160
„ 300 ditto - - - - -	299,120
„ 400 ditto - - - - -	356,080
500 ditto - - - - -	413,040

SUMMARY.

Estimate of works for raising the sewage of the metropolis to a height of 200 feet.	
Engines, pumps and buildings:	
5,696 HP. at 100 *l.* - - - - - - - - - -	569,600
Pumping mains - - - - - - - - - - -	506,800
Summit reservoirs - - - - - - - - - -	550,000
Distributing mains - - - - - - - - - -	2,414,720
	4,041,200
Contingencies - - -	404,120
TOTAL - - -	4,445,320

	£.	
Estimate of Revenue, working expenses, and profit income from sale of 219,540,000 tons of sewage at 1 *d.* per ton - - - - - - - - - - -		914,750
Working expenses:—		
Fixed expenses independent of pumping lift - - - - - -	128,240	
Pumping expenses, 5,696 × 20 - - - - - - - -	113,920	
		242,160
Profit - - - £.		672,590

Or 15·1 per cent. on the capital.

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SUMMARY OF ESTIMATES.

LIFT.	200 Feet.	300 Feet.	400 Feet.	500 Feet.
	£.	£.	£.	£.
Engines and pumps - -	569,600	854,400	1,139,200	1,424,000
Pumping mains - - -	506,880	3,471,600	3,471,600	3,471,600
Reservoirs - - - -	550,000			
Distributing mains - -	2,414,720			
	4,041,200	4,326,000	4,610,800	4,895,600
Contingencies - -	404,120	432,600	461,080	489,560
TOTAL - - - £.	4,445,320	4,758,600	5,071,880	5,385,160

TABLE of Revenue, Working Expenses, &c.—Profit.

LIFT.	200 Feet.	300 Feet.	400 Feet.	500 Feet.
	£.	£.	£.	£.
A. Revenue at 1 *d.* per ton -	914,750	914,750	914,750	914,750
Working expenses fixed -	128,240	128,240	128,240	128,240
Cost of pumping - -	113,920	170,880	227,840	284,800
B. Total expenses - -	242,160	299,120	356,120	413,040
Balance, being Profit=A—B £.	672,590	615,630	558,670	501,710
Dividend - - -	15·1°/o	12·9°/o	11·0°/o	9·3°/o

2 August 1862.

(signed) *Samuel Hughes.*

76, Warwick Square, Belgravia,
9 July 1863.

Sir,

IN the Appendix to this letter, marked No. 1, you will find a copy of a letter from the eminent firm of Leeds solicitors, the Messrs. Payne, Eddison, & Ford, from which the Metropolitan Board of Works will learn that a sum of 60,000 *l.* is ready to be lodged in bank to the credit of my local trustees (so soon as a conditional concession of the sewage shall be granted to me), as a fund to cover all expenses of establishing a company to carry out my plan for the economic and profitable utilisation of the metropolitan sewage. This is, of course, enormously in excess of what will be required, but should the Board consider necessary further proof of my ability to carry out successfully my own plans for the economic utilisation of the sewage, I beg to suggest that an additional stipulation can be added to the conditional concession, to the effect that I shall not take any steps to advertise my company until the Metropolitan Board of Works shall have first approved of my Board of Directors, and that half-a-million sterling of the capital of my company has been subscribed for.

In the Appendix, marked No. 2, you will find a copy of a letter lately received from Baron Leibig, from which the Board will see that my plan of an economic utilisation of the metropolitan sewage receives the entire approval and support of the greatest authority in the world upon agricultural chemistry.

In the Appendix, marked No. 3, you will find suggestions for an agreement between the Metropolitan Board of Works and myself with reference to a concession of the sewage of the metropolis, which the Board will be pleased to consider my renewed tender for the same.

I desire now (as they bear upon my tender) to draw the attention of the Board to the objections which have been raised against the economic and profitable utilisation of the London sewage, but which, fortunately for the heavily-taxed ratepayers of the metropolis, the owners of the property, will not bear one moment's examination.

It is alleged that the sewage is "so extremely diluted that it is useless as manure, unless enormous quantities are applied." Those, however, who urge this theory seem to forget that the sewage of the metropolis has been analysed by a number of chemists of high standing and character, amongst whom I may mention the names of Hofman and Witt, Frankland, Versmann, Leithby, and Rogers. These all agree in stating, that in 1,250 tons of average London sewage, such as will necessarily be found at the outfall tanks of the Board, there is an amount of fertilising matter which, if extracted and dried, would not be less than that found in one ton of the best Peruvian guano; but, as manure, for a variety of reasons, shown by the witnesses examined before the Select Committee of the House of Commons on Sewage of Towns, was proved to have at least double the effect upon a crop if applied in the liquid state, it follows that the effect on a crop of the fertilising matter contained in 1,250 tons of average London sewage, if applied in the liquid state as we find it in the sewage, must be at least equal to that produced by two tons of the best Peruvian guano, provided that it be properly applied to the land, so that none of it be lost off the surface, or sink down into the soil beyond the reach of the roots of the crop. Now, two tons of guano would be sufficient, as every farmer knows, to manure richly over 14 acres of ground; therefore, 1,250 tons of the London sewage, if properly applied, would be sufficient for twice that quantity of land.

The correctness of this position is proved by the profitable and beneficial results obtained with small dressings of sewage by several of the witnesses examined before the Select Committee of the House of Commons on Sewage of Towns, and in particular by Philip W. S. Miles, Esq., of King's Weston, Bristol. That gentleman obtained a most extraordinary improvement in the quantity and quality of all the crops to which he applied sewage, and that sewage was much poorer than that of London, as it contained nothing but the excreta of 30 persons, which must have been enormously diluted, or it would not have been spread over the 14 acres to which it was applied, even once in the year; how much greater, then, will this dilution appear, when we learn from Mr. Miles' evidence that all the 14 acres were dressed at least two or three times every year? And yet, by the use of this "extremely diluted sewage," Mr. Miles raised the value of the land from 2*l.* 10*s.* to 5*l.* 10*s.* per acre per annum. It is not clear, then, from this that had Mr. Miles purchased this manure from a company he could have well afforded to pay a very considerable price for it, and yet have been a great gainer by its use?

Mr. Miles, by a careful and economic application to his land of this manure, was able to show a clear profit of 1*l.* 8*s.* per person per annum for the sewage applied, whilst Mr. Lawes, who is at the head of those who urge upon the public "the theory of extreme dilution of sewage" as a reason why it should still be treated as a nuisance and not as a valuable article of commerce, competing with his artificial manures, only showed a return from his experiments on Mr. Campbell's farm at Rugby (conducted by him for the Royal Sewage Commission) of from 1*s.* to 2*s.* per person per annum.

But the reason for this poor return, so different from that obtained by Mr. Miles, is easily understood. Mr. Lawes applied this liquid manure in enormous dressings to the land, and as a matter of course the land was to a great depth reduced to the condition of a morass, upon which nothing but inferior produce would grow; after which the remainder of the sewage ran away to loss as fast as it was put on. Then, by charging against the crop all the sewage applied, 99 hundreds of which was in all probability lost, he was enabled to show a return of only from 1*s.* to 2*s.* per person; but I submit that these "burlesque experiments" in no way show the real agricultural, and therefore the commercial value, of sewage as a manure, contradicted as they are by the results obtained by numerous witnesses examined before the Select Committee on Sewage of Towns. But, although they in no way show the value of sewage, they do most conclusively prove that the system recommended by him, that of enormous dressings over small areas, is utterly erroneous.

The different results obtained by these two gentlemen are sufficient to solve the question of sewage utilisation, and show conclusively how untenable is the opposition to an economic and profitable utilisation of sewage, on the ground of its alleged "extreme dilution." These results show that if the sewage be applied in moderation, the earth will have power to extract from it all the manure which it contains, improving wonderfully the quantity and quality of the produce, and enabling those using the manure to pay largely for it, to the great benefit of the ratepayers. Whereas, if applied in large quantities, the earth will be overburthened and overpowered, and the manure flow away to loss; thus rendering it impossible, for those who would use it in this wasteful manner, to make any return for it to the ratepayers.

Another objection raised to the economic and profitable utilisation of the London sewage is, "That owing to the large area over which it would have to be distributed it would cause a nuisance." Those who make this objection would appear to be entirely ignorant of every thing relating to the cultivation of the soil, or they would be aware of the fact that farm yard manure is very offensive; but as the land must be manured if we are to have food, no one is found to object to manure being put on land on the ground of its being "a nuisance." But although solid farm yard manure when spread on land remains in an offensive state for many days, yet a liquid manure like sewage, if applied in moderation, would cease to give out the slightest offensive odour the moment after it had been applied to the crop, as it would be at once absorbed by the earth and deodorised. This is abundantly proved by the evidence of Lord Essex and other witnesses examined before the Select Committee on Sewage of Towns. In addition to which I may add that under the conditions of the concession I shall not have power to distribute any of the sewage within a line round London, to be drawn by the Metropolitan Board of Works; and that further, I shall not obtain my Act empowering me even to commence my works until I shall have satisfied Parliament that the public will not be either annoyed or injured by any of the operations of my projected company; and, in the event of the Act being obtained, the Metropolitan Board of Works and the ratepayers shall, by the provisions of that Act, be exonerated and held harmless from all liability.

Another objection urged against the economic and profitable utilisation of the sewage is, "the vast amount of its daily flow, which must be disposed of day by day, as it will not admit of accumulation." In addition to which it is urged "that you cannot apply it at all times to the land"; but, on reference to my letter to the Chairman of the Board, bearing date the 31st December 1861, it will be seen that those objections are fully met, and I may here remark that the opinions then advanced by me have all been supported by the evidence since then taken by the Select Committee on Sewage of Towns. In that letter I showed that there was no time of the year when sewage manure might not be applied with advantage to some portion of the land on almost every farm upon a given area; and this is proved to be the case by the evidence of several witnesses examined before the Select Committee on Sewage of Towns, amongst whom I may mention Lord Essex. His Lordship had used and still uses sewage with great success upon all descriptions of crop. In answer to Question 35 his Lordship says, "It is stored up as it were in the land, and put it on when you like, it remains in the soil till it is wanted by the plants." And in answer to Question 11 his Lordship says, "I put it on my land daily somewhere or other." His Lordship thus exhausts upon a portion of his demesne all the sewage of the town of Watford; he is not overpowered by it, for we gather from his evidence that his Lordship would gladly have more sewage if he could get it for the rest of his land. What then is done with the sewage at Watford can evidently be done elsewhere; it is simply a question of area. But what is the correct extent of area required profitably to absorb the sewage of the metropolis in addition to the farm yard manure manufactured upon that area? In the detailed calculations, which will be found in the Appendix to my letter to the Chairman of the Board, bearing date the 31st December 1861, I showed that, having regard to the interests of the ratepayers, and to insure for them a fair price for their property, the area for the distribution of the sewage, assuming that the Board could deliver to me 266,052,241 tons per annum, should not be less than 532,104 acres. The correctness of this calculation has since been established by the evidence taken by the Select Committee.

Another objection which struck at the root of the economic and profitable utilisation of the metropolitan sewage, was the alleged "engineering impossibility to distribute by steam power over a suitable area so vast a quantity of sewage." This objection was put forth in a report of Mr. Thomas Wicksteed, Civil Engineer to the Metropolitan Commissioners of Sewers, printed by order of the House of Commons, and strongly insisted on in a pamphlet by Mr. Lawes; and, I may add, generally accepted as correct by the public. But in my letter to the Chairman of the Board, bearing date the 31st December 1861, I explained not only the errors of Mr. Wicksteed's report, but gave the most full and minute details of the only plan by which it is possible, profitably and safely, to distribute by steam power the entire sewage of the metropolis over a suitable area.

The information furnished to your Board was not volunteered by me; the Board was placed in possession of it in consequence of their advertisements calling for tenders for the sewage, and in consequence of the personal request of the Chairman of the Board, made to me upon the occasion of my waiting upon him with a gentleman in my employment, with reference to the utilisation of the London sewage, as well as in consequence of the Board's letter to me of the 16th November 1861.

Having deposited with the Metropolitan Board of Works the full details of the only plan of distribution, by means of which the entire sewage can be safely and profitably delivered over a suitable area, I proceeded at considerable expense to make that plan public, with a view to benefit the ratepayers by arousing public opinion to the great importance of the economic and profitable utilisation of the metropolitan sewage; I therefore respectfully submit to the Board that I have a legal title to the ownership of all the information which I have furnished to the Board, and that having been shown by me that it was possible to utilise the sewage of the metropolis with profit to the ratepayers, it is not legally open to the Board to grant a concession of the sewage to any company, or to any individual proposing to distribute the sewage upon my plan or any colourable alteration of it. I, however, feel confident that it is unnecessary for me to press upon such a body as the Metropolitan Board of Works my legal rights, but only that I should draw attention to them, especially as I am in a position to carry out successfully my own plans for the benefit of the metropolitan ratepayers.

As my letter of the 31st December 1861 has not yet been taken into consideration by the Board, and as it contains all necessary information with reference to the utilisation of the sewage and the fullest and most minute details of my plan, much more indeed than would be required by Parliament, I forward with this a copy of it for the information of the Board.

With reference to the expense of my works, I beg to state that the exact amount cannot be determined until a careful survey of the entire area has first been made. Such a survey would require a large staff of engineers for a considerable time, and would cost a very large sum. This great labour and expense I cannot prudently incur until a definite arrangement has first been entered into between the Board and myself with reference to a conditional concession; but from the rough estimates which have been made by myself as well as by Mr. Samuel Hughes, C.E., who is now acting as the engineer for my projected company, I feel justified in stating that the cost of the works for the economic and profitable utilisation of the entire sewage of the metropolis will be considerably under 3,500,000*l.*

I wish now respectfully to draw the attention of the Board to two or three clauses in the advertisement of the Board calling for tenders for the sewage, which, if strictly acted on, would throw great, and indeed insurmountable obstacles in the way of the only method of dealing with the sewage, from which the ratepayers ever can derive any advantage commensurate with its great value.

The first clause to which I would draw attention is that "all tenders must be accompanied by a plan and section showing their several details."

Those tendering for the sewage, or say half of it, who proposed to put it on a limited area, say 20,000 acres, from which, of course, no return could possibly be made to the ratepayers commensurate with the value of the manure which would be lost, would find no sort of difficulty, and be put to scarcely any expense, in complying with this clause; whereas I, whose works, to enable me to reach 532,104 acres, must extend over an area of double that extent in order to allow for the roads, water, houses, &c., upon the area would have enormous difficulty and be put to a vast expense in furnishing this information which, I may here remark, would be useless to the Board when furnished, and would not be required from me by Parliament when applying for my Bill.

The second clause to which I would wish to direct attention is, that information is required as to "the quantity and locality of the land over which it is to be distributed, the points at which the sewage is to be intercepted, &c."

I have already, in my letter of the 31st December 1861, shown the quantity of land around London required for the profitable absorption of the sewage, but it is quite impossible for me to give the locality of each particular field on the area upon which those who shall hereafter purchase the sewage may please to put it. Neither can I state the points along my lines of distributing mains at which the sewage may hereafter be "intercepted," as that must depend upon the customers of the Company. But this information could of course be given by those proposing to put the sewage upon a limited area, the land being in their own occupation.

The next clause to which I would wish to draw attention is, "that in any contract provision must

App. No. 14. be made to secure to the Board the return of the sewage works and the full power to relet and deal with the same, and so that the Board may, in case of the failure of the contractors in their operations, be left to their full rights and without any cost to the Board."

With reference to this clause I would remark that the works will be laid down at the risk of the shareholders of a great Company, and not of any "contractors." My proposed works are simply for the purpose of utilising the sewage in the liquid state for agricultural purposes, and not for manufacturing a solid manure and purifying the sewage as at Leicester. If, then, it did not pay for a company to continue to deliver the sewage to the farmers, it would not pay for the Board to do so. And as the works would not be of any use for sanitary purposes, as are the works at Leicester, which works were lost to the company that erected them, in consequence of a similar penal agreement with the Corporation of Leicester, the Metropolitan Board of Works could be no gainers by the insertion of so hostile a clause in the concession, but which, if insisted on, would probably prevent the raising of the requisite capital, and thus inflict a great injury upon the owners of the sewage, the ratepayers, by preventing the economic and profitable utilisation of their property.

The next clause to which I would wish to draw the attention of the Board is, that the tenders "must contain the names of two or more securities to be approved of by the Board, who shall be jointly and severally bound in a competent sum for the efficient execution of the works, in accordance with the provisions, and subject to the limitations of the Metropolis Local Management and Main Drainage Acts."

With reference to this clause I have again to observe, that all the works for the economic and profitable utilisation of the sewage will be undertaken at the risk of a great Company, and not of individual "contractors." This Company cannot commence any works until it shall have obtained its Act of Incorporation, in which due provision shall, as a matter of course, be made to protect the Metropolitan Board of Works, the ratepayers, and the public from all loss or annoyance. And it will be the Company, when formed, who will let the contract for the works, and not the Board.

It will, therefore, be to the Company, and not to the Board, that the Contractors will have to give security "for the efficient execution of the works."

In conclusion, I wish to draw the attention of the Board to the fact that, under the provisions of the concession of the sewage, for which I have applied, the ratepayers will be entitled to one-half of all the profits made by the Company, which share will not be less than 700,000 *l.* per annum. And further, that, by great exertions and a free expenditure of money, I may yet be enabled to have my surveys and plans completed in time to go to Parliament next Session for my Act, provided the Board shall at once grant me the conditional concession for which I now apply; but should any delay take place it is certain to throw me back for another year, to the great loss of the heavily-taxed ratepayers of the metropolis, by delaying for another 12 months the commencement of the works for the economic and profitable utilisation of their property.

I am, &c.
(signed) *Thomas Ellis.*

To John Pollard, Esq.

APPENDIX No. 1.

COPY of Letter from Messrs. *Payne, Eddison,* and *Ford,* Solicitors.

70, Albion-street, Leeds,
Sir, 30 June 1863.

WE beg to inform you that our clients are prepared to place in bank, to the credit of your local trustees, a sum of 60,000 *l.* as a fund for promoting and carrying out your plan for the economic and profitable utilisation of the metropolitan sewage, upon the Metropolitan Board of Works granting you the concession of the sewage upon satisfactory terms. We cannot, however, advise our clients to lodge so large a sum and keep it idle until known that you have obtained the conditional concession that you have applied for, and the terms upon which it will be granted; for, although we apprehend there would not be any difficulty in disposing of the entire stock, provided a liberal concession be made, yet we think it would be impossible to establish the Company, unless the Board were disposed to act towards you with satisfactory liberality.

Yours, &c.
(signed) *Payne, Eddison, & Ford.*

To Thomas Ellis, Esq.,
76, Warwick-square, Belgravia, London.

APPENDIX No. 2.

COPY of Letter from Baron *Liebig.*

Sir, Munich, 22 June 1863.

THE pamphlet which you have sent me, and your letters, have given me much pleasure by showing me that there are many excellent men fighting to promote that great national question, the economical utilisation of sewage.

I have sent, to-day, to Mr. Mechi, an article written, to be printed in "The Times," which I hope will contribute to forward and realise your views.

The enemies most to be feared to the application of sewage are undoubtedly the manufacturers of artificial manures, particularly of superphosphates of lime. These manufacturers are a very stupid set of people, because the application of sewage to agricultural purposes must necessarily increase tenfold their trade. This I tried to show in my article, and to fix all the money value which the sewer water of the metropolis may have.

In my new work, "The Natural Laws of Husbandry," you will find many arguments to convince people of the necessity of the employment of sewage.

The most important for men like you, is not to lose patience, and to persevere in that good cause. I can tell you that my doctrine has very often received, as people believed, its death-blow, but it was always fresh and growing, and yet, in the present moment, there is not a single farmer in Germany and France who is doubting the truth of it; and if your endeavours arrive at their end, and you are successful, people will in 10 years not believe that there was a great struggle to establish the application of sewage.

Believe me, &c.
(signed) *J. Liebig.*

To Thomas Ellis, Esq., London.

APPENDIX, No. 3.

SUGGESTIONS for an Agreement between the Metropolitan Board of Works and *Thomas Ellis*, of 76, Warwick-square, Belgravia, with reference to a Concession of the Sewage of the Metropolis.

1. THAT a company be formed, and its Act of Incorporation obtained from Parliament, within a time to be fixed by the Metropolitan Board of Works.

2. That the sewage be applied in the liquid state to the land, and, in order to prevent nuisance by the application of large quantities to the land, as well as to secure the greatest return for the benefit of the ratepayers, that it be sold by the ton to the farmers, the sewage in all cases being made to pass through water meters before being delivered on each farm.

3. That, previously to the sewage being delivered on the land, it shall be completely freed from all offensive smell (should it have any), if so required by the Metropolitan Board of Works.

4. That the duly appointed officers of the Metropolitan Board of Works shall, at all times, have free access to the Company's works, and that the Board shall, on their report, have the absolute power (upon giving a written order to that effect) to immediately stop and suspend the further distribution of the sewage, should it at any time be found in a state likely to cause a nuisance, but that such suspension of the works shall at once cease upon the sewage being fully deodorised.

5. That the Company receive the sewage of the Metropolitan Board of Works from the outfall tanks of the Board, and that the Company be permitted to have free access to such outfall tanks at all times.

6. That the Company shall pump the sewage from wells constructed in the neighbourhood of the outfall tanks up to a summit regulating reservoir upon either side of the Thames, from whence it shall be allowed to descend by gravitation through pipes laid along the roads of the area to be irrigated.

7. That the regulating reservoirs shall not be constructed upon any spots that have not first been approved of by the Metropolitan Board of Works. Nor shall the sewage be delivered on the land within a line round London, to be drawn by the Metropolitan Board of Works.

8. That, to prevent all fear of nuisance, the regulating reservoirs shall be covered.

9. That for the purpose of distributing the sewage, the Company (hereafter to be formed) shall erect all necessary machinery, and construct all necessary works at their sole expense and risk.

10. That the Company be empowered to let flow any or all of the sewage into the river, provided that, from any accident to the works, or other cause, the entire amount of the sewage, or any portion of it, cannot at any time be applied to the land; the Company undertaking, in such case, that previously the sewage shall be deodorised and precipitated.

11. That the Company by their Act of Parliament (which must be approved of by the Metropolitan Board of Works before it is applied for) shall undertake all liabilities of every kind which may arise from their operations, and shall hold the Metropolitan Board of Works and the ratepayers entirely harmless.

12. That all profits derived from the sale of the sewage, after deducting working expenses, management, reserve fund, &c., shall be equally divided between the Metropolitan Board of Works and the Company.

13. That the management of the Company be vested in a court of directors, three of whom shall be nominated by the Metropolitan Board of Works (if they so desire it) from their own body, such Directors to remain on the direction only so long as they shall continue members of the Metropolitan Board of Works.

14. That the concession of the sewage by the Metropolitan Board of Works shall be in perpetuity, with the right to the Board to purchase out the interest of the shareholders after 50 years, giving three years' notice. The price to be paid to be determined by valuators mutually chosen by the Metropolitan Board of Works and the shareholders of the Company. And that the concession shall be granted to Thomas Ellis, the promoter of the Company, conditionally, upon his forming the Company upon the above terms (or such alterations of them as shall be mutually agreed on) within a time to be fixed by the Board; failing which, the conditional concession shall be forfeited.

TENDER to the Metropolitan Board of Works from the Honourable *William Napier* and *William Hope*, Esquire, V. C., for the Disposal of the Sewage discharged by the Main Outfall Sewers on the North Side of the Thames.

To *John Thwaites*, Esq., Chairman of Metropolitan Board of Works, from the Honourable *William Napier* and *William Hope*, Esq., Victoria Cross.

(Confidential.)

2, Old Palace Yard, Westminster, S.W.,
Sir, 30 October 1861.

IN accordance with the obliging permission granted to us, at our interview with you this day, we have the honour to submit to you, as Chairman of the Metropolitan Board of Works, the following preliminary sketch of the definite scheme we propose hereafter to lay before the Board for the utilisation of the sewage of the northern area of the metropolis for agricultural purposes.

We are aware that no proposal of this nature can be entertained by you, which does not present the fullest guarantees as to efficacy and permanency, and fulfil the obligations cast on the Metropolitan Board by the 24th clause of the Act

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of Parliament of 2d August 1858, which makes it imperative that any scheme for the utilisation of the sewage approved by the Board shall be free from the charge of nuisance, whether above or below ground.

It is generally accepted that town sewage can be most economically carried and most beneficially applied as an agricultural fertiliser in a liquid state by its own gravity, and upon light soils.

We propose to take the whole of the sewage at some convenient point on the east side of the River Lea, and, starting with a regulating reservoir, to convey it in a closed brick culvert, or in iron pipes, as may be most advantageous, to the Maplin Sands and Dingie Flats on the coast of Essex, between the mouths of the Thames and the Blackwater, and divided by the River Crouch, and which have a combined available area of from 30,000 to 40,000 acres.

We propose to embank these lands from the sea and to apply the sewage—

1st. To form the land by a wet warp; and,

2d. As a constant fertiliser, as is done near Edinburgh.

We believe that the sewage may be thus employed with a fair beneficial return on the large capital which will be requisite, without danger of nuisance of any kind whatever, and that by thus obviating the discharge of so large a body of foul matter, at the intended outfall immediately below Woolwich, this scheme, should it present all other necessary guarantees to the Metropolitan Board and the public, is one deserving of confidence.

We are enaged at this time, by the aid of Mr. G. W. Hemans, civil engineer, in preparing such plans, sections, and estimates as are requisite to determine the questions of fall to the desired outlets, and of cost of the proposed conduit and embankment of the sands.

When these are completed, we shall have the honour of submitting to you before the end of November a full statement of the scheme, with the capital required, and with proper guarantees for its execution, should it obtain the approval of the Board; and, in the hope of this eventuality, we are taking such preliminary steps as are necessary to avail ourselves of the ensuing Session of Parliament.

We have, &c.
(signed) *William Napier.*
W. Hope.

Metropolitan Board of Works,
Spring Gardens,
Gentlemen, 15 November 1861.

I am directed to acquaint you that the Chairman has laid before the Committee to whom has been referred the consideration of the several propositions for taking the sewage of the metropolis, your communication of the 30th October last, containing a preliminary sketch of a scheme for utilising the sewage of the northern area of the metropolis for agricultural purposes.

The Committee, after considering your proposition in conjunction with those received from other parties, arrived at the conclusion that, before coming to a final decision with respect to any of them, it would be necessary that they should have every possible opportunity for testing the efficiency of the scheme in an engineering and chemical point of view, and for satisfying themselves that the requirements of the Act of Parliament relating to the subject shall in no way be infringed by the creation of a nuisance in carrying out the works.

With this view I am to request that you will be good enough to supply a map and sections shewing the area of the intended operations, the levels of its surface, and the lines, levels, and sizes of the intended acqueducts, indicating the various kinds of surface soil with which it is proposed to deal, and shewing in detail what mode of subsoil drainage it is intended to adopt, if any, with the size, depth, and inclination of the several proposed lines of drainage, together with descriptions and particulars of the pumping power to be employed, the number of lifts, and the nature of the outfall.

Also a statement, shewing the manner in which it is proposed to work the scheme, what kind of powers will be taken for dealing with the land to be operated upon, and how owners and occupiers are to be treated with, what quantity of sewage will be taken up daily, over what quantity of land it will be distributed, what depth it will occupy over that area of land, and, if it be intended to employ varying quantities at different seasons, what that variation will be.

Also, a full statement of the means of deodorisation, if any, the chemical agents employed, and the details of their mode of application, and what arrangements, if any, it is proposed to make for dealing with the heavy deposit.

Also an estimate shewing separately the costs of the engines and pumps, if any, the conducting pipe or sewer, the distributory and deodorising apparatus and the subsoil drainage, together with the annual working expenses of each of these three heads of expenditure.

I am, &c.
(signed) *John Pollard,*
Clerk of the Board.

The Hon. William Napier.
W. Hope, Esq.

2, Old Palace-yard, Westminster, S.W.,
Sir, 25 November 1861.

In compliance with your request, conveyed in Mr. Pollard's letter of the 15th inst., and in partial redemption of our promise given in our communication of the 30th ult., we have now the honour to submit, for the consideration of the Metropolitan Board of Works, as much of the information required as we have been able as yet to prepare by the able assistance of Mr. G. W. Hemans and his staff.

We beg leave to forward herewith an Ordnance map, on which is shown the area of the intended operations upon the Foulness Sands and Dingie Flats, and which will ultimately have an extent of upwards of 20,000 acres, and also the line of the intended aqueduct.

The works consist in the construction of a main conduit, 10 feet in diameter and 37 miles in length, with two open branches to the areas, north and south of the Crouch, of seven and eight miles in length respectively.

A copy of the section of the lines of the entire culvert and its branches, and plans of the same, as to be deposited in the offices of Parliament on the 30th instant, will be duly forwarded for your information, as well as a copy of the Parliamentary notice of the powers to be obtained from the Legislature.

The surface soil of the areas to be operated upon consists chiefly in an admixture of sea sands and fluvatile silts in different proportions, and a more detailed explanation of which will be added hereafter.

It is not at present considered that it will be necessary to provide any subsoil drainage, but merely to place a catch-drain, or canal, inside the line of the embankments to retain the surplus water after irrigation for discharge into the sea through ordinary valve sluices.

There will be but one lift on the line of culvert at about the ninth mile from Abbey Mill, and in a deep cutting. The force required will be about 40 horse-power per foot, or 1,200 horse-power for the lift of under 30 feet.

We propose to take the entire dry weather sewage of the northern area of the metropolis summer and winter.

As, during the earlier period of the reclamation, a part of the sewage may be disposable, it is proposed to arrange for its distribution to farms on the line of the culvert at such places and distances from London and from populous districts as will preclude all possibility of nuisance, and the quantity thus utilised not absorbed by the land will be carried by the feeders of the Rivers Crouch and Roach into the sea.

The Bill to be brought into Parliament in the ensuing Session will recite the agreements to be made with the Crown and other proprietors as to their rights over the lands to be reclaimed, and the arrangement which we hope to effect with the metropolitan board.

It has thus been seen that our scheme obviates the necessity of any artificial system of deodorisation, which will be completely accomplished by the natural process of filtration through soils expressly adapted for it.

The gross amount of the estimates for the culverts, sea walls, irrigation and pumping is 2,000,000 *l.* sterling, full details of which will be forwarded hereafter.

It is proposed to incorporate a company under the provisions of the Bill now to be deposited for the subscription of the capital and the working of the scheme should the necessary grants be obtained from the Metropolitan Board and the Crown.

We have to ask your indulgence, sir, for not being ready with the commercial prospectus and the statement of the financial and public support to be given to the scheme.

The preparation of the plans, sections, references, notices, and estimates has entirely absorbed our time up to the present moment, but these being now nearly completed, thanks to the energy of Mr. Hemans, we shall very shortly be in a position to redeem the remainder of our promise, and we respectfully point out the very heavy costs we are now incurring as a guarantee of good faith, which we hope you, sir, and the Board of Works will regard as satisfactory.

We have, &c.
(signed) *William Napier.*
W. Hope.

John Thwaites, Esq.,
Chairman of the Metropolitan
Board of Works.
&c. &c. &c.

Metropolitan Board of Works,
Spring-gardens,
Gentlemen, 7 December 1861.

The Committee who have under their consideration your proposition for taking the sewage of the northern area of the metropolis will meet at this office on Tuesday next, the 10th instant, at 12 o'clock, and I am to request that you will be good enough to be in attendance in order to afford the Committee any further explanation which they may desire on the subject.

I have, &c.,
(signed) *John Pollard,*
Clerk of the Board.

The Hon. W. Napier, and
W. Hope, Esq.

2, Old Palace Yard, Westminster, S. W.
Sir, 9 December 1861.

We now have the honour to submit to you for the consideration of the Metropolitan Board of Works, a statement in general terms of the conditions on which we are prepared to take over the sewage of the northern area of the metropolis.

1. The grant of the sewage to be conditional on the ratification by Parliament of the grant by the Crown of the land which it is proposed to operate upon.

2. The right of the Company to the sewage to be absolute and exclusive for a period of 50 years, commencing from such time as may be fixed upon by the Board, and sanctioned by Parliament for the completion of the works.

3. The works of the Company to be capable of taking the ordinary dry weather discharge as estimated by the officers of the Board, at 10,000,000 cubic feet per diem.

4. All net profits realized by the Company in excess of 10 per cent. on their total outlay to be equally divided between the Company and the Board, such profits to be verified by the Company's auditors, in conjunction with an auditor to be appointed by the Board of Trade. Should the net profits in any year, after the completion of the works, not equal 10 per cent. on the outlay, the Company to be compensated from the profits of the following years.

5. In the event of the Company making sales of the land, and realising more than the original cost of their whole works, together with the stipulated 10 per cent. per annum, all profit over and above the sum thus standing at debit on the books of the Company to be divided between the Company and the Board.

6. All money realised by such sales of land to go to the credit of the capital account of the Company.

7. On giving seven years' notice, the Board to have the right to take over, at the expiration of the grant of fifty years, the whole of the Company's works and land at a valuation, such valuation in no case to be below the total original cost as passed by the auditors above mentioned.

8. In the event of the Board not wishing to exercise this right, a new concession of the sewage to be granted to the Company for fifty years on the same terms.

9. The Board to be represented in the management of the Company by a Director, to have all the powers of an ordinary Director, with the same fees.

These,

App. No. 14.

These, Sir, are the general conditions which we respectfully submit to the Board as a basis for a provisional agreement to be incorporated in the bill about to be presented to Parliament.

We do not think it right to lay before you vague estimates of the profits to be realised by the Company and the Board from this enterprise, but we shall have the honour to furnish personal explanations on this subject to-morrow, in compliance with your request.

We have, &c.
(signed) *William Napier.*
W. Hope.

John Thwaites, Esq.,
Chairman of the Metropolitan
Board of Works, &c. &c. &c.

2, Old Palace Yard, Westminster,
Sir, 10 December 1861.

I have taken the opportunity of consulting some of the principal supporters of our scheme for utilising the sewage of the north of London on the two clauses in our proposal of yesterday's date, Nos. 4 and 9 respectively, which it was the desire of the Metropolitan Board of Works at their meeting to-day should be modified, and I now have the honour to inform you, in Mr. Napier's name as well as my own, that we are willing to agree to the alteration in clause 4, which appeared to meet the wishes of the Board, namely, that the latter part of the clause, empowering the Company to make good any deficiency in the profits of one year out of the profits of the succeeding years, should only apply to the first five years after the completion of the Company's works.

We are also very happy to accede to the wish of the Metropolitan Board to have the nomination of two directors instead of only one as originally proposed, in the belief that the more thoroughly the operations of the Company are examined and superintended by the Board, the more reason the Board will have to feel satisfied with the scheme as a sanitary measure as well as on general grounds; and in the full confidence that, as the interests of the Board and of the Company will, in most respects be identical, we are not sacrificing the interests of the shareholders in the slightest degree by making such an arrangement.

I may here be permitted to observe, with reference to the question of nuisance raised by some of the members of the Board, that we find, after visiting the Craigentinny Farm, near Edinburgh, that no process of warping the land will be in the least necessary. One portion of the Craigentinny meadows was formed out of hillocks of pure sea sand, blown up by the wind slightly above high-water mark, and Mr. Christy, the proprietor, informed us that this pure sand, after receiving a good watering from the liquid sewage of Edinburgh, produced very nearly as fine crops the first year as it does now after more than 20 years. He added that the present yearly rental of this the poorest portion of the property averaged about 18 *l.* per imperial acre. Mr. Christy further informed us that, after a crop of grass is cut at Craigentinny, the roots are left of a pale sickly yellow, yet that in a single night after the sewage irrigation of the meadow, this colour is changed to a luxuriant green, proving the almost instantaneous absorption by the vegetation of the properties in the sewage offensive to animal life. In further proof of this, and in support of my other statements, I beg to refer to the report of Lord Essex's commission, presented to Parliament in 1858.

With respect to what passed yesterday in relation to the Bill to be brought before Parliament in the ensuing Session, I fear, from a conversation that I have had with our solicitors, that it will not be possible to present the Board with copies at as early a date as they desired. The Bill is at present being drawn up by counsel, and we cannot undertake to name a day by which it will be finished, but as soon as it is ready it shall be at once submitted to the legal advisers of the Board; and in order to remove an impression to the contrary which appeared to prevail yesterday, I may state that any amendments or alterations which the Board may subsequently desire can be introduced when the Bill is in Committee.

I have, &c.
(signed) *W. Hope.*

John Thwaites, Esq.,
Chairman of the Metropolitan
Board of Works, &c.

Metropolitan Board of Works,
Spring Gardens,
Gentlemen, 3 January 1862.

I AM directed by the Metropolitan Board of Works to request that you will be good enough to forward, for distribution amongst the members of the Board 50 copies of the Bill of the "Metropolitan Sewage and Essex Reclamation Company" to be placed in their hands immediately, as the subject comes before the Board for discussion on Friday next.

I have, &c.
(signed) *John Pollard,*
Clerk of the Board.

To the Hon. W. Napier, and
W. Hope, Esq.

METROPOLITAN SEWAGE COMPANY.

2, Old Palace Yard,
Sir, Westminster, 6 January 1862.

THROUGH some unfortunate accident, we did not receive Mr. Pollard's letter of the 3d instant until to-day. We regret to learn that the requisite copies of the Bill had not been sent to your office for distribution among the members of the Metropolitan Board. We had given instructions that they should be sent, but, in the pressure of business, the agents had overlooked their memorandum. Their omission has now been rectified.

We take advantage of this opportunity to explain away, by anticipation, certain objections which might possibly be raised to our proposals, or which, at all events, have been started by other parties.

It has been asserted that, were our contemplated works to fail, or only to be temporarily suspended in their action, a very heavy expense would be entailed upon the Board. This is, however, quite a mistaken idea. In such an event the connection with the Company's culvert would simply be shut off by means of a sluice, and no expense would be incurred by the Board whatever. No doubt, the expense will remain entailed on the Board of completing their outfall to Barking Creek; but we apprehend that under no circumstances would the Board have placed themselves and the London public at the mercy of any private company whose works might or might not have fulfilled the promised objects, and that the outfall, as originally projected by the Board, would in every case have been completed independently of all other works.

An objection has been raised to our Bill as not being sufficiently binding, and as not reciting the contract between the Board and the Company; but, in the present position of the negociations, it was only possible to ask for powers for the Company to enter into such contracts as the Metropolitan Board might agree to.

We feel that we need scarcely notice another objection that has been raised, namely, that as yet no Company has been formed; for the Board are, of course, well aware that without a definite concession or agreement it is impossible to obtain the confidence of the public.

We are satisfied that if the Board should grant us a provisional concession, based upon the conditions which we had the honour to submit to you, and which gained the approval of the Drainage Committee, such concession will not merely receive the approbation of Parliament, but also the cordial support of the public.

In conclusion, we beg to thank you, sir, and the members of the Board, for the patient consideration which they have devoted to our proposals.

We have, &c.
(signed) *William Napier.*
W. Hope.

John Thwaites, Esq.,
Chairman of the Metropolitan
Board of Works, &c.

METROPOLITAN SEWAGE COMPANY.

2, Old Palace Yard, Westminster,
Sir, 9 January 1862.

As it is very possible that at the approaching general meeting of the Metropolitan Board some of the members, not on the Drainage Committee, may be desirous to receive some additional information respecting our scheme, I have the honour to state that, if you deem it advisable, I shall be very happy to attend the meeting with the engineer of the project, Mr. G. W. Hemans, to answer such questions as the Board may think fit to address to us.

I have also written to another of the Directors of the proposed Company, the Honourable Henry William Petre, to request him to make arrangements, if possible, to enable him to come up to town on Friday morning. As Mr. Petre resides in the county of Essex, and is very intimately acquainted with the ground to be operated upon, which is contiguous to part of the property of his brother, Lord Petre, and as he has taken pains to ascertain the feelings of the neighbouring proprietors and inhabitants with respect to the scheme, the Board will probably be glad to avail themselves of his information.

Mr. Napier will, I regret to say, be again prevented from attending by his protracted illness, which, indeed, yesterday assumed a very threatening aspect, and caused us much anxiety, though, I am glad to say, that Dr. Watson, who was called in by his regular medical attendants, pronounced a favourable opinion, and to-day he is decidedly better.

I have, &c.
(signed) *W. Hope.*

John Thwaites, Esq.,
Chairman of the Metropolitan
Board of Works.

Metropolitan Board of Works,
Spring Gardens,
Sir, 9 January 1862.

THE chairman is not at present aware of any point upon which additional information is likely to be required, but he thinks that your presence and that of Mr. Hemans might probably be of advantage during the discussion in case of any question arising which may not have been foreseen. The chairman has desired me to remind you that your proposition for dealing with the sewage of the northern area of the metropolis will be considered to-morrow at one.

I am, &c.
W. Hope, Esq. (signed) *E. Cresy.*

2, Old Palace Yard, Westminster,
Sir, 28 January 1862.

As the time is now drawing near for the discussion of our proposal to the Metropolitan Board for the utilisation of the sewage of the northern area of London, we consider that it would be convenient to the Board to be furnished with that proposal in a condensed form, as it has undergone a slight modification since it was originally presented.

Our scheme remains unaltered, as it was thoroughly matured before it was submitted to the Board, and subsequent investigations have only strengthened our convictions of its soundness and confirmed our calculations.

The nine general clauses submitted in our letter of the 9th December last, with the alterations suggested by the Main Drainage Committee, and embodied in the letter of the 10th December, remain as the basis on which the concession for which we ask is to be drawn up, with this modification, "that the time for obtaining the necessary powers from Parliament be extended over the session of 1862–1863.

If the Board, at the adjourned discussion, feel that they would be consulting the interests of the public in granting us this provisional concession, we, on the other hand, pledge ourselves to use our utmost exertions to obtain the requisite suspension of Standing Orders, for which there is more than one precedent, to permit of our lodging the deposit and proceeding with the Bill during the ensuing session.

We have, &c.
(signed) *William Napier.*
W. Hope.

J. Thwaites, Esq.,
Chairman of the Metropolitan
Board of Works.

2, Old Palace Yard, Westminster,
Sir, 6 February 1862.

WE have read and considered attentively the various motions with respect to our proposal for utilising the sewage of the northern area of London, notice of which has been given for the meeting of the Metropolitan Board to-morrow.

These motions involve very considerable modifications of the proposal as originally submitted by us; and, while we are very willing to accept all such changes as we believe will not affect the successful carrying out of our scheme, we must, sir, draw your attention to others which we believe would render this desirable result impossible, and upon which conditions, therefore, we cannot undertake the concession.

App. No. 14.

In the fifth notice of motion it is proposed to reduce the preference dividend of the Company from 10 per cent. to 7½ per cent. for the latter half of the period of the concession. In drawing up our proposal we purposely took the very lowest figure for the preference dividend upon which it appeared to be practicable to raise so large a capital, and we now respectfully beg to adhere to that part of our scheme as being absolutely essential.

We are aware, sir, that these motions will be moved in no spirit of hostility to us or our scheme, for the notices have been given by the same gentlemen who, on a former occasion, enounced opinions so favourable to our project, but we have, of course, given much more time and thought to its details than can have been in the power of any members of the Board; and, should this proposed motion be carried, we shall be compelled reluctantly to withdraw our proposals from a conviction of the impossibility of raising the required capital.

We cannot, also, consent to that part of the ninth notice of motion which recites, "or if no renewal be granted at the termination of the lease," for as the Company could not be responsible for this eventuality, they could not fairly be subjected to a penalty.

To all the other changes we cheerfully accede, and, as a further satisfaction to the Board, we have the honour to state that we are prepared to undertake to raise the share capital of the company, and commence operations within two years from the date of the concession, and to place a deposit of 25,000 *l.* in such Imperial, Indian, or Colonial Government securities as may be agreed in the hands of trustees on behalf of the Board and of the Company, to be held in trust until the Company shall have expended 500,000 *l.* on their works, when the 25,000 *l.* shall be returned to the Company. That if the Company fail to execute their contract, the said 25,000 *l.* shall be forfeited to the use of the Metropolitan Board, but that until the expiration of the trust, the dividends shall be paid to the Company.

Hoping that this proposal will meet the approbation of the Board,

We have, &c.
(signed) *William Napier.*
W. Hope.

John Thwaites, Esq.,
Chairman of the Metropolitan
Board of Works,
&c. &c. &c.

2, Old Palace-yard, Westminster,
Sir, 15 February 1862.

Having been informed that the Board have indefinitely adjourned the consideration of our scheme for the utilisation of the sewage of the northern area of the metropolis, we are reluctantly compelled to withdraw all that part of our proposal which refers to the financial conditions of the proposed concession.

We desire it to be distinctly understood that we do not abandon our project; but, inasmuch as the financial conditions were framed in the belief that the concession would be granted by the Board, and an Act of Parliament obtained during the present Session, now that the consideration of the entire question is postponed, as we understand, to the Report of a Committee of the House of Commons, not yet even granted, we can no longer hold ourselves bound to conditions which an uncertain future may find impossible of accomplishment.

We shall be much obliged, sir, by your communication hereafter of the re-opening of this important question by the Board, when we shall hope, strengthened by further investigations, to present another financial arrangement for the execution of the general project, which we still leave in your hands.

We have the honour to tender our best thanks to you, sir, and the members of the Board, for the attention given to our proposals, and remain,

Yours, &c.
(signed) *William Napier.*
W. Hope.

John Thwaites, Esq.,
Chairman of the Metropolitan
Board of Works.

Metropolitan Sewage.

2, Old Palace-yard, Westminster,
Sir, 24 February 1863.

As I understand that proposals have again been made to the Board of Works for the use of the sewage to be derived from the northern area of the metropolis, I have the honour to acquaint you, that if the time has arrived at which the Board are in a position to receive tenders for the utilisation of the sewage, I am prepared, in conjunction with Mr. William Hope, to renew the offer made last year, and trust that it may receive favourable consideration.

The very large expense incurred in the preparation of the plans and estimates in conjunction with the proposed utilisation of the sewage on the sea coast of Essex, will, I hope, be considered as the justification of this request, that I may be informed by the Board as to the time at which they will be prepared to receive tenders.

I have, &c.
(signed) *William Napier.*

John Thwaites, Esq.,
Chairman of the Metropolitan
Board of Works,
&c. &c. &c.

DESCRIPTION of the WORKS proposed.

The Board are requested to refer to the previous tender of Messrs. Napier & Hope, of the 25th November 1861, relative to which it is now proposed again to describe the intended works, a fresh set of the plans and sections, with a general map, being forwarded herewith.

It is proposed to take the whole of the dry weather sewage, or 10,000,000 cubic feet per day, at a point near the Abbey Mills, from the level to which it will be lifted by the engines of the Metropolitan Board; it will be conveyed in a culvert from this level for a distance of nine miles, with a gradual fall, and it will then be lifted by further pumping to a height of 30 feet.

From the ninth mile, the culvert will be continued at the higher level by Upminster, Houndon on the Hill, and nearly parallel to the Southend Railway to the thirtieth mile, whence it will diverge by Rochfort, across the head of the river Roach, and passing over Foulness Island, will discharge its contents by gravity on the Maplin Sands, which are to be reclaimed from the sea.

The total length of this culvert will be 44 miles.

A branch of the length of eight miles and a half will cross the river Crouch, near Burnham, and discharge upon the Ray Sands and Dengie Flats, near Tillingham.

These sands are also to be reclaimed from the sea.

The sewage is to be used for the irrigation of these reclaimed lands, for which purpose it will be distributed by gravity over their surface.

The extent of land to be reclaimed will be from 15 to 20,000 acres.

Only one junction with the sewers of the Metropolitan Board is contemplated, being that at Abbey Mills, and no provision against floods or failure of pumping power on the part of the projectors of the proposed works, is considered necessary, inasmuch as the Metropolitan Board will always have the power to turn the sewage into the Thames at Barking Creek, at any time, as originally contemplated.

The projectors will, however, for their own purposes, make their pumping engines in duplicate.

It is not intended to use any deodorization for the sewage, which will be discharged upon absorbing sands at a distance from all population.

The amount of capital to be invested, will be 2,000,000 *l.*, but the number and value of the shares is not yet decided upon.

The projectors request from the Metropolitan Board, a concession or grant of the sewage for 50 years, on the following terms:—

1. The grant of the sewage to be conditional, on the ratification by Parliament of the grant by the Crown, of the land which it is proposed to operate upon.

2. The right of the Company to the sewage to be absolute and exclusive, for a period of 50 years, commencing from such time as may be fixed upon by the Board, and sanctioned by Parliament, for the completion of the works.

3. The works of the Company to be capable of taking the ordinary dry weather discharge, as estimated by the officers of the Board at 10,000,000 cubic feet per diem.

4. All net profits realised by the Company in excess of 10 per cent. on their total outlay, to be equally divided between the Company and the Board, such profits to be verified by the Company's auditors, in conjunction with an auditor to be appointed by the Board of Trade.

5. Should the net profits in any year after the completion of the works not equal 10 per cent. on the outlay, the Company to be compensated from the profits of the following years. This clause only to apply to the first five years.

6. In the event of the Company making sales of their land, and realising more than the original cost of their whole works, together with the stipulated 10 per cent. per annum, all profit over and above the sum thus standing at debit on the books of the Company, to be divided between the Company and the Board.

7. All money realised by such sales of land to go to the credit of the capital account of the Company.

8. On giving seven years' notice the Board to have the right to take over, at the expiration of the grant of 50 years, the whole of the Company's works and land at a valuation, such valuation, in no case, to be below the total original cost, as passed by the auditors above mentioned.

9. In the event of the Board not wishing to exercise this right, a new concession of the sewage to be granted to the Company on such terms as may be settled by an arbitrator, to be appointed by the Secretary of State for Home affairs.

10. The Board to be represented in the management of the Company by two Directors, to have all the power of ordinary Directors with the same fees.

11. The necessary powers to be obtained from Parliament, and the Company to be formed within two years.

12. Within three months after the formation of the Company, a sum of 25,000 *l.* to be placed by them in the hands of trustees nominated by the Board and the Company, to be invested by them in India, 5 per cent. stock, and the interest to be regularly paid to the credit of the Company until three-fourths of their works shall have been completed, when the capital sum shall be delivered up to them. If, however, the Company abandon their enterprise before three-fourths of their works have been completed, then the sum of 25,000 *l.* shall be handed over as a forfeit to the Board.

With reference to that portion of the advertisement requiring the giving of sureties for the performance of the contracts, if undertaken, the offer of deposit of 25,000 *l.*, made in the previous proposal, to be forfeited failing due performance of the obligations assumed is hereby renewed.

(signed) *William Napier*,
for Self and
William Hope.
London, 8 May 1863.

John Pollard, Esq.,
Clerk of
Metropolitan Board of Works,
Spring-gardens, London.

Metropolis Sewage and Essex Reclamation Company.

6, Furnival's Inn,
6 January 1862.

Sir,

I BEG leave to enclose a statement prepared by the direction of George Finch, Esq., of Burley, Rutlandshire, the owner of the greater part of the Island of Foulness, to be laid before the Metropolitan Board of Works.

Having been informed that the Board will, on Friday next, take the proposed measure into consideration, I shall be obliged by your informing me if the Board will permit me, as Solicitor, and Mr. Wood as Land Agent to Mr. Finch, to attend it on his behalf.

I have, &c.
(signed) *G. Bramwell.*

To the Secretary or Clerk of the
Metropolitan Board of Works.

App. No. 14.

STATEMENT of *George Finch*, of Burley, Rutlandshire, Esq., in regard to the Bill intended to be brought into Parliament by the Metropolis Sewage and Essex Reclamation Company.

MR. FINCH is owner of the Island of Foulness, on the coast of Essex (with the exception of a small part of it); and it will be seen by the plan deposited with the Clerk of the Peace for Essex, by the promoters of the measure, that it is intended to carry the sewerage directly through the island, and which proceeding, if effected, would materially damage Mr. Finch's estate.

The island is defended from the sea by walls erected and maintained at great expense, and from a vast expanse of sands, which are overflowed by the sea every tide, and over which sands the sewerage is proposed to be discharged, in order to their reclamation as agricultural land.

If the proposed scheme be carried out, the walls, or part of them will be interfered with, and the island thereby subjected to inundation by the sea.

A letter addressed by Mr. Finch to his solicitor, Mr. Bramwell, will more fully explain his objections to the proposed scheme; the following is a copy of that letter:—

"Burley, 31 December 1861.

"My dear Sir,

"I have good reason to object to the proposed drainage measure. Not only will the drain perforate my sea-walls, cut through my estate, and seriously interfere with the sewerage of the Island of Foulness, but half the filth of London will be permanently deposited close to the eastern part of the island; the air will become pestilential, and the island will become almost uninhabitable.

"The two great objections to the Bill, in a general point of view, are:—

"1st. The delay which the scheme would necessitate in the completion of the London drainage.

"2d. The ruinous nature of the speculation, so that, eventually, the Main Drainage of the northern districts of London would depend for its maintenance upon a company of bankrupt speculators.

"That a considerable delay must ensue must be very evident; for, first, the work could not be undertaken until a sufficient capital had been subscribed; and, secondly, there must be a very minute and accurate survey, and the construction of 44 miles of drainage, cutting through hills and filling up valleys, would require a considerable time to effect.

"That the speculation would be ruinous is evident to everyone who is acquainted with the nature and locality of the sands proposed to be enclosed, and of the violence of the sea and tide, when agitated by the north-eastern and eastern gales.

"The expense of the proposed drainage of 44 miles must be very great. It must be upon a large scale, capable of containing a sufficient influx of water to carry down the ordure 44 miles. The expense of the sea-walls would be very great. There is nothing but light sand on the spot; not a stone is to be found.

By the Act of Parliament passed nine years ago, in the event of an enclosure taking place, the Company are bound to build and endow churches, and to make roads, and they must build farmhouses and cottages, all the materials for which must be fetched from a distance. Even if the ordure mixed with the sand could be converted into soil, many years must elapse before many thousand acres could be covered with a cultivable soil ten inches thick; and, at first, in order to persuade tenants to locate themselves, and to plough up such a filthy soil, for some years the land must be let at a nominal rent. Hence, if the cultivation of a large portion of the sand could eventually be effected, many years must elapse before any large portion of it could be cultivated, and, for that time, there would be no profit for the capital expended.

But the notion of enclosing the vast portions of sand in front of the east coast of Essex and of Foulness Island is a romantic dream. The defence of the present sea walls mainly consists in the vast expanse of sand in front of them, which operates as a defence against the sea. When the east, north-east, and south-east gales blow, the sea rolls in with immense force, and rushes up the Thames. Walls constructed near the deep water would inevitably be thrown down or flooded. The land flooded with sea water, as is known by sad experience, will not grow corn for six or seven years afterwards. Any large portion of the sand cannot be safely or permanently enclosed; and if, after a few years, a few thousand acres could be converted into cultivable land, and securely enclosed, the portion allotted to wheat would not pay the speculators one per cent. on their capital.

"In fine, the maintenance of the Main Drainage of London would be left in the hands of a company of bankrupt speculators. If the Board of Works would wish to have any information respecting the nature of the sand, the force of the sea in the storms, &c., my agent, Mr. Wood, will be very happy to afford it, either in London or at Foulness.

"Yours, &c.
(signed) "*G. Finch.*"

As it is understood the promoters of the measure have applied to the Metropolitan Board of Works for their concurrence in the scheme, Mr. Finch is desirous of laying this statement before the Board.

Metropolitan Sewage and Essex Reclamation Company.

Furnival's Inn,
5 February 1862.

Sir,

SINCE the date of my last letter to the Metropolitan Board of Works, objecting to the above measure on the part of my client, Mr. Finch, the principal owner of Foulness Island, I have been instructed by him to cause a scientific examination of the locality to be made by a competent engineer.

That gentleman has this morning returned from Foulness, and is at present engaged in preparing his report, a copy of which I hope to be able to deliver to you, together with specimens of the sand, before the meeting of the Board on Friday next.

I trust that the Metropolitan Board of Works will be pleased to afford Mr. Finch the opportunity of laying his report before the full Board, and having his engineer personally examined in support of it, before coming to a decision on the subject.

I shall feel obliged by your communicating this letter to the Board on Friday next, for their information.

I have, &c.
(signed) *G. Bramwell.*

John Pollard, Esq.

London, 25, Bedford-square, W.C.,
Sir, 5 February 1862

I HAVE examined the plans and sections of the "Metropolis Sewage and Essex Reclamation" Company, and have made a survey and examination of Foulness Island, the sea-walls and embankments, and the site of the proposed works on the Essex coast.

The Company propose to obtain a concession, from the Metropolitan Board of Works, of the sewage of the north side of the Thames, to take it from the proposed pumping-station at Abbey Mills and convey it across the south-eastern part of Essex to the Foulness Sands and Dengie Flats. At about two miles from Burnham, the line of conduit will diverge in two directions: one, called the "main line," is to traverse Wallasea Island, cross the River Roach at Quay Reach, and proceed across the middle of Foulness Island to the Foulness Sands at Eastwick Head; the other line is to cross the River Crouch on the west side of Cricksea Ferry, pass on the north side of the town of Burnham, cross the Southminster and Dengie Marshes to the Dengie Flats, at a point about half a mile south of Filingham Coastguard Station.

Second. To enclose the Foulness Sands by an embankment or sea-wall, commencing at Shelford Head, on the north side of Shelford Creek, running out across the sands, at right angles with the coast, a distance of 2½ or 3 miles; then, following the line of the outer edge of the sands, near the level of low-water, for a distance of 9 miles; and then along the south side of the entrance to the River Crouch up to Foulness Point, a distance of about 4 miles, where it will join the present sea-wall: the total length of this new wall is 15 miles and 50 chains, and embraces an area of 22 square miles, or 14,000 acres.

Third. To enclose the Ray Sands, Dengie Flats, and St. Peter's Sands, by an embankment commencing at Holywell Point, on the north side of the River Crouch, following the course of the outer edge of these sands, at about two miles' distance from the present walls, and terminating at Sale's Point, on the south side of the River Blackwater: the total length of this wall is 10 miles and 5 chains, and embraces an area of 13 square miles, or 8,000 acres.

Fourth. To fertilize with the sewage the area included between these new walls and the present walls, and to obtain the feesimple of those lands when reclaimed.

The position of the embankments and the lines of the conduits are shown on the accompanying map. I have been informed that from Abbey Mills to the point of divergence, near Burnham (37 miles), it is proposed to make a covered conduit; and from this point to the two outlets the sewage is to be conducted along the open channel, with the exception of the parts where it is to cross the Rivers Crouch and Roach, where iron pipes will probably be placed under the bed of these rivers. Whether this be the intention or not of the Company I cannot say: the plans deposited at the Private Bill Office show a conduit or channel of some sort, apparently 15 feet deep—sometimes in cutting, sometimes in tunnelling, and sometimes in embankment. Across Foulness Island and the Dengie Marshes, it is shown in 15 feet embankment, with the outlets of the level of the ground.

The land proposed to be enclosed and reclaimed consists of the saltings, an irregular tract of land at the foot of the present sea-wall, varying on Foulness from 100 to 150 yards in width; these are covered with vegetation, principally samphire and marine grasses, and being higher than the level of the sands, they form an excellect protection to the sea-walls. On the Dengie Flats the "saltings" are much wider in some places, being nearly half a mile wide.

Outside the saltings is a tract of sands called "Black Grounds," consisting of very fine sands, coloured with the carbonaceous matter derived from the decomposition of seaweed, and having seaweeds intermixed and growing upon them. On the Foulness Sands they vary from 10 to 20 chains in width, and on the Dengie they extend much further: in fact, nearly the whole of the Dengie Flats partake of the character of the "Black Grounds." Outside these lie the "Sands" or foreshore, having a fall of five feet per mile, and forming an excellent breakwater to the present sea-walls; these sands are hard and firm at low-water, but are quicksands of a dangerous description. Vessels grounding on them invariably become wrecks, and settle down; some disappearing entirely in a few days, others being partly visible for some weeks, but in all cases they ultimately disappear, and are buried in the sands. It must be borne in mind that none of this is land from which the sea has receded, but the whole of the sands and blackgrounds are covered by the sea every tide, and, in fact, form a portion of the German Ocean. Those next the proposed wall are covered with water 20 feet deep at spring tides, and the "Black Grounds" are covered two or three feet at the same time.

Near low-water, on the Foulness Sands, there are numerous little channels or rills running down to the main channel, and the Dengie Flats are intersected by large watercourses, which carry the fresh water from the mainland out to sea. These are wide and important, and cannot be stopped up, as they drain a large portion of the Dengie Hundreds.

From borings taken on Foulness Island, for the purpose of making artesian wells, it has been found that there is, under the whole island, sand for a depth of 40 feet, of precisely the same character as the sand on the beach; there are 14 or 15 of these artesian wells on the island, and the strata pierced were as nearly as possible the same in each case. The 40 feet of sand was uniformly met with, a conclusive proof that there is at least the same depth on the present unenclosed sands. Above the sand, on the eastern side of the island, there is three feet of made ground, and on the west side about six or eight feet; below the sand lies the clay, into which the bore-holes extend about 350 feet before water is obtained. The wells are all artesian, or nearly so, as the water rises to within three or four feet of the surface of the ground.

In considering the proposed scheme, we have first to consider the practicability of constructing a wall capable of sustaining from 20 to 25 feet of water on a quicksand 40 feet deep, situated three or four miles out in the sea, and exposed to the heavy roll of the German Ocean. This wall, if it be possible to make it, will have to be, at the least, 30 feet in height. Whether the promoters contemplate carrying their embankment through the 40 feet of sand down to the clay I know not; but it is certain that any attempt to build it on the sands would be a failure, as the materials would (as in the case of stranded ships) sink into the sands as fast as they were placed there.

The next difficulty that presents itself is that there are no materials at hand wherewith to make the embankment, either on the sands or through the sands. The present banks are made from time to time out of the "saltings," taking care to have a sufficient quantity of these outside the new walls to protect them and act as a breakwater. From the deposited plans it may be surmised that the promoters intend to make use of the reclaimed land on the island at Newlands and Shelford Head, where they have scheduled about 600 acres of land. In these places there is only three feet of soil over the sand, and it certainly seems absurd to remove land already reclaimed and in a high state of cultivation, in the hope of being able to reclaim other land of inferior quality, and the quantity to be obtained from these places would not be sufficient to form the proposed embankment. Failing this source, chalk can be procured from Grays for 2*s.* or 2*s.* 6*d.* a ton, and Kentish ragstone, from near Maidstone, from 3*s.* 6*d.* or 4*s.*; but the quantity required of these materials would be so enormous that their cost would be fatal to the project.

The Parliamentary sections show the top of the proposed walls throughout their entire length, of the same height as the present walls. A little consideration will convince anyone that this height will be insufficient, as there is no analogy between what is necessary in the two situations. The present walls are from seven to eight feet above the "saltings," and being protected by them and the rise of the sands up to the saltings, by the time the tide reaches the bank its fury is expended, and it breaks with a gentle ripple on the banks; ordinary spring tides rising about three feet up the bank, leaving the remainder four or five feet to resist unusually high tides and the "swash" caused in heavy seas by the wind. A bank, with 36 feet base and slopes of three to one next the sea and of two to one next the land, is found quite sufficient without stone facing where there are "saltings" and a foreshore of sand to protect it; a section of this wall is given, and marked A. But the case of a wall three or four miles out to sea is totally indifferent here; there will be no breakwater, and the waves will dash against it with great violence. Instead of a depth of three feet of water there will be a depth of twenty feet at spring tides, and in its exposed situation will certainly require to be much higher than the present walls.

Supposing the company prepared to go to the enormous cost requisite for making a sufficient wall, another difficulty arises as to when it is to be done. Three hours each tide is the longest it will be possible to carry on the works, or six hours in twenty-four; but as the working hours will frequently occur at night and in rough weather, four hours in every twenty-four is as much as it will be possible for the men to work, and during the progress of the works it will be impossible to keep the sea from breaking over them and carrying them away as fast as they are made.

By reference to the map it will be seen that some parts of the proposed walls will be exposed to the winds in every direction. But the portion most exposed will be the five miles running in a north-easterly direction from Foulness Point. There is a portion of wall on the north side of the island, next the River Crouch, similarly situated, and here it has been found necessary to make a wall of a superior description. A drawing of this wall is given and marked B, by which it will be seen that it has a base of 76 feet with slopes of four to one next the sea, faced with Kentish ragstone, nine inches thick on chalk, and slopes of two to one on the land side. There is rather more than a mile of this wall; and, although of so expensive a nature, this portion is constantly being damaged, as the sea sets in with great force against it. The five miles of new wall alluded to will be subjected to similar damage, but to a much greater extent.

With reference to any damage the proposed works are likely to cause to the island (a matter in which Mr. Finch is more nearly interested), I must mention that the flood tide, as it approaches the mouth of the River Crouch, will be, by the proposed embankments, deprived of an area of 35 square miles, over which it now flows freely. The effect will be to force the water up the river with increased velocity, thereby jeopardising the safety of the walls on the north side of the island. The "saltings" here are already diminishing daily, and have to be faced with stone to preserve them, and any increased rush of waters must necessarily injure them as well as the walls which they protect. It may even be found necessary to increase the height and strengthen the whole of the walls on the north side of the island.

Between Shelford Head and Foulness Point there are seven inlets or "gutters," as they are called, through the banks, for the purpose of supplying the ditches in the interior of the island with water. These are essential, for without them the ditches would be dry, the cattle stray from field to field, and ditches emit a most offensive smell; whereas when supplied, as now, with water there is no smell, and they serve as the only fences for keeping in the cattle. On the north and west sides of the island there are corresponding outlets, and the ditches are so arranged that the water flows through them freely. No provision is made for these on the Parliamentary Plans.

The only land communication the island possesses is a public road on the sands from Wakering Stairs to Fisherman's Head, with communications to Asplin's Head, Rugwood Head, and Eastwood Head; these will all be destroyed by the proposed scheme, and cause great inconvenience to the inhabitants, as by these roads they get their supplies daily; they are, in fact, their only mode of communication with Rochfort and the surrounding neighbourhood, of which hundred the island forms a part, and the traffic to and fro is considerable.

The area of Foulness Island is about 6,300 acres, and the area proposed to be covered by the sewage 20,000 acres, or three times the size; what the effect will be of two such bodies of sewage water in the immediate vicinity of the island can hardly be doubted. It is not possible that the enormous quantity of sewage water which will be brought down from London will soak into the sands; they are already saturated with salt water and cannot be drained; the consequence will be that these two large bodies of sewage will constantly emit effluvia as noxious as it is offensive, and with the island intersected by a large open channel conveying the sewage to the sands, it may fairly be presumed that thenceforth Foulness Island will be utterly unfit for habitation.

In addition to the last-mentioned nuisance vast quantities of the sewage will annually find its way into the sea, and as salt water, when in contact with sewage, disengages the sulphuretted hydrogen of the latter producing the disagreeable state of things so loudly complained of in London two years ago, the nuisance will merely be removed from the metropolis to be located and immensely intensified in this neighbourhood.

One other important objection to the scheme remains to be mentioned, and that is the effect the proposed embankment will have on the sandbanks and channels in the immediate vicinity, situated as these works are, near the mouth of the Thames, in the midst of most intricate sands, where the channels are barely sufficient for what is required, and are decreasing daily, such works if seriously intended to be carried out, cannot but be looked upon with alarm by those interested in the welfare of the navigation. The question to be determined is, what will be the effect of carrying Foulness Point four miles forward, and depriving the tidal channel of 35 square miles of area? If the space now occupied by Foulness Sands be inclosed, they will probably accumulate outside the proposed embankment and endanger the "Swin Channel"; the same effect will in all probability take place outside the embankment on the Ray Sands, and endanger the Ray Sand channel; and it is not impossible that the Buxey Sand might be joined to the Ray Sand, or to Foulness Sand, or to both, and thus effectually block up the mouth of the Crouch.

These points will, as a matter of course, receive the attention of the Board of Admiralty, and if there is any probability, however remote, of those works injuring the navigation of this part of the sea the promoters of the scheme may rely upon it that the Board will never consent to the carrying out of the proposed works.

I have, &c.
(signed) *George Hopkins.*
George Bramwell, Esq.

13, Queen-square, Westminster, S. W.,
Sir, 13 February 1862.

My attention has only just been called to a report signed George Hopkins, contained in a letter to the agent of Mr. Finch, the proprietor of the Island of Foulness, on the coast of the Maplin Sands. This report comments very severely on the project of the Honourable William Napier and Mr. William Hope, and to which I am engineer, to reclaim part of those sands, as well as the Dengie Flats.

Mr. Hopkins, with no knowledge whatever of the mode of carrying out the works contemplated by me as engineer to the project, assumes, in default of accurate information, sundry propositions as to the state of things intended, which he proceeds to characterise as absurd and impracticable, and he dwells with alarm on the probability that sands, which in one part of his letter, he describes as "hard and firm" at low water, "will nevertheless behave as quicksands," as regards our proposed embankments, and will swallow them all up.

However, I will take Mr. Hopkins' objections *seriatim*, and make some brief replies, but it is not to be expected that in any place, except before a Committee of the House of Commons, the whole of the merits or defects of the scheme of Mr. Napier can be developed.

1st objection. The quicksands are to swallow up all our works, these sands being at least 40 feet deep.

I should be sorry even to insinuate anything offensive against Mr. Hopkins, of whom I have no knowledge whatever; but I must state, that he cannot be well informed on the subject of embankments on sands, in some of which, and of great magnitude, I have been myself engaged.

There are very extensive embankments composed on sands of unlimited depth, and composed chiefly of the sands themselves, faced with a coating of clay, stones, or fascines, as the case may be; such embankments I have myself constructed, and others have done so to a much greater extent. The term "quicksands," is in fact, very delusive, and is to a great extent, in the sense used by Mr. Hopkins, "a bugbear." Quicksands are simply sands of a fine grained description, easily moved by water. When a wreck lies upon them on a shoal ground, the eddies of the rising and falling tides draw away the sands by rippling round the wreck, and the mass, of course, gradually sinks from losing its support. Exclude the water, or keep it in the sands, and they will support any amount of weight.

It is not, however, intended as Mr. Hopkins imagines, to build the proposed embankments three or four miles out to sea, or in situations where there will ever be, nearly so much as 20 feet of water upon them. As regards the Dengie Flats, Mr. Hopkins' objection about quicksands, does not apply at all.

Foulness Island lies below the level of high tides, and as Mr. Hopkins states, consists of a mere skin of soil over a depth of sand of 40 feet. It has been wholly reclaimed by moderate sized embankments from the sea, and yet the sands are obviously precisely the same as those outside the embankments, which latter, according to Mr. Hopkins' view, ought to have been swallowed up when first constructed.

2d Objection. Numerous channels and rills draining off the fresh water, and admitting, when required, the tidal waters to the Dengie and Foulness coasts are, Mr. Hopkins assumes, to be stopped up by our works to the great detriment of the internal lands.

The simple answer to this is, that nothing of the kind is intended. Ample provision will be made for existing outfalls, and for such new and improved ones as may be necessary.

3d Objection. That there are no materials to make the embankments with.

The answer to this is, that the whole of the existing embankments on the Essex and other coasts, are composed of the mud or sands themselves *in situ* in some cases protected with a mere facing of clay or stones, or fascines brought from other places. Ample foreshores will be left outside the embankments to protect them. Chalk for facing can be procured in large quantities cheaper than Mr. Hopkins imagines, but on the Dengie Flats but little will be required; instead of three hours at each tide, it is expected that in the situations where the walls are to be erected, from five to six hours will be available, but a part of the work

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work may be done entirely independent of the tides.

4th Objection. That the only road into Foulness, that between Wakering Stairs and Fisherman's Head, will be entirely shut up. This road is only open at low water, but it is a most gratuitous assumption that it is intended to stop it up. On the contrary the passage of that road over our embankment will be made perfectly good and easy. More than half the road will, under the protection of our walls, be always high and dry, and available at all hours, whereas now it is only a track in the mud for a few hours at low water.

5th Objection. The sewage water is, Mr. Hopkins thinks, to lie on the 20,000 acres proposed to be reclaimed near Foulness, which surface being impregnated with salt water cannot imbibe it, and cannot be drained. Consequently all the neighbouring atmosphere will become offensive, and Foulness will be uninhabitable.

I am much astonished at these assertions coming from one whom I presume to be a civil engineer.

Is it a fact that the hundreds of thousands of acres which have been reclaimed from the sea in England and Holland, remain always "impregnated with salt water?" Is it a fact that "they cannot be drained?"

Mr. Hopkins must surely be aware that salt rapidly disappears owing to the action of rain and sweet waters after the exclusion of the tides from reclaimed land, and as to drainage, why cannot gravitation carry off the inland and salt waters as well as through our embankments (as far as the fall allows), as it does now through all the existing embankments on the coast? But by what right is it assumed that no mechanical, or steam, or wind drainage is intended in aid of gravitation? Is not such aid employed most economically over vast districts? What then does Mr. Hopkins mean by saying that our particular enclosures cannot be drained? The real intention is not to let the sewage lie on the soil, but to draw it through by drainage, and to discharge only clear water into the sea.

6th Objection. Mr. Hopkins goes into theories of the effect of the abstraction of tidal waters, and the dangerous velocities to be caused by us in the River Crouch, the embankments along which are to be destroyed according to him; he adds that all the sailing channels will be disturbed, and that the Admiralty will never consent to such embankments.

What right Mr. Hopkins has to pledge the Admiralty I cannot imagine. He will, I suppose, be surprised to learn that the Admiralty did approve of very similar embankments on the same lands in the year 1852, and that, having laid the present project before them, Mr. Napier and myself had the honour to receive the full approval of the reporting officer, who only suggested a slight alteration in one of the lines, and who stated his opinion that the works would be highly beneficial to the entrances of the Crouch and Blackwater.

I think, Sir, it is needless to combat further at present the assumed difficulties raised by Mr. Hopkins, but I cannot conclude without expressing my astonishment that Mr. Finch, the proprietor of the 6,000 acres of Foulness Island, should be advised to oppose a project which must become, if carried out, in the highest degree beneficial to his property.

We propose to carry to his broad acres of thin, dry, and shallow land an inexhaustible source of the richest liquid manure, the judicious use of which would probably quadruple his rent, and change the whole character of the neighbouring country into a highly fertilised soil.

His embankments would be secured and protected by new ones, far outside the present ones, which he would not have to keep in repair. Instead of the desolate sands covered at high tides, he would have rich farms between him and the sea, while a busy population would be engaged on the large estates of the Reclamation Company, whose presence must enhance the value of land and produce on all that part of the coast.

All the coast lands from the River Blackwater to the Thames are deficient in fresh or rain water, depth of soil and manure. We offer, what is equivalent to all these wants both to the existing lands and to the lands we propose to reclaim. It does appear extremely shortsighted to oppose what ought to be sought for as an incalculable benefit.

I have, &c.
(signed) *G. W. Hemans.*

J. Pollard, Esq.,
Clerk to the Hon. Board of Works,
Spring-gardens.

Sir, 17 February 1862.

At the meeting of the Metropolitan Board of Works, held on Friday last, the subject of the several propositions for taking the Sewage of London was brought under the notice of the members, and I laid before them your letter of the 13th instant, containing observations on the allegations in the report by Mr. Hopkins, in reference to the schemes of Messrs. Napier and Hope, but the attention of the Board having been called to the fact of the intention of Government to acquiesce in the appointment of a Committee of the House of Commons to inquire into the best means of utilising the sewage of the cities and towns of England with a view to the reduction of local taxation and the benefit of agriculture; they adjourned the further consideration of the matter until that Committee shall have made their report.

I am, &c.
(signed) *John Pollard,*
Clerk of the Board.

G. W. Hemans, Esq., C.E.,
13, Queen-square, Westminster, S. W.

13, Queen-square, Westminster,
Sir, 19 February 1862.

In reference to your letter of the 17th instant I regret to hear that an inquiry instituted by the House of Commons has been the cause of preventing your Board's consideration of Mr. Napier's utilisation scheme; as this scheme cannot, however, long be kept back, and I consider that the minds of many members of your Board may be unfairly prejudiced against it by the letter of Mr. Hopkins, which you have printed and circulated amongst them, I beg to request that you will be so good as to give my letter the same advantages by printing it and circulating it among the members of your Board.

I am, &c.
(signed) *G. W. Hemans.*

John Pollard, Esq.,
Metropolitan Board of Works,
Spring-gardens.

Metropolis Sewage and Essex Reclamation Company.

6, Furnival's Inn,
Sir, 27 March 1862.

By the desire of Mr. Finch I beg leave to forward to the Metropolitan Board of Works a further statement which he has received from Mr. George Hopkins, together with a copy of the Admiralty Report referred to in the statement which I request you will be good enough to lay before the Board.

I have, &c.
(signed) *G. Bramwell.*

To John Pollard, Esq.

Metropolitan Sewage and Essex Reclamation Company.

25, Bedford-square, W. C.,
Sir, 24 March 1862.

I beg to acknowledge the receipt of the printed copy of Mr. Hemans' letter of the 13th February 1862, addressed to the Clerk to the Metropolitan Board of Works, and in compliance with your request, on behalf of Mr. Finch, I send you my observations in reply.

For facility of reference, and to avoid the errors inseparable from partial extracts, I have transcribed Mr. Hemans' letter verbatim, and written my observations side by side at the places where they apply.

I am, &c.
(signed) *George Hopkins.*

George Bramwell, Esq.

Mr. Hemans' Letter.	*Mr. Hopkins' Observations in reply.*
13, Queen-square, Westminster, S.W., Sir, 13 February 1862. My attention has only just been called to a Report, signed George Hopkins, contained in a letter to the agent of Mr. Finch, the proprietor of the Island of Foulness, on the coast of the Maplin Sands. This report comments very severely on the project of the Hon. William Napier and Mr. William Hope, and to which I am engineer, to reclaim part of those sands, as well as the Dengie Flats.	
Mr. Hopkins, with no knowledge whatever of the mode of carrying out the works contemplated by me as engineer to the project, assumes, in default of accurate information, sundry propositions as to the state of things intended, which he proceeds to characterise as absurd and impracticable; and he dwells with alarm on the probability that sands, which in one part of his letter he describes as "hard and firm" at low water, "will nevertheless behave as quicksands," as regards our proposed embankments, and will swallow them all up.	Although I had not the advantage of knowing the details of the project, the plans and sections deposited at the Private Bill Office, show the leading features of the scheme sufficiently to enable anyone to form an accurate notion of what is intended, and an examination of the site of the proposed works enabled me to form an opinion upon them. The sands are firm enough for a person to walk upon them, and will bear a momentary pressure, but with continued pressure they immediately begin to move; they are precisely of the description which Mr. Hemans, in a following paragraph, characterises as true quicksands.
However, I will take Mr. Hopkins' objections *seriatim*, and make some brief replies; but it is not to be expected that in any place, except before a Committee of the House of Commons, the whole of the merits or defects of the scheme of Mr. Napier can be developed. 1st. Objection. The "quicksands" are to swallow up all our works; these sands being at least 40 feet deep. I should be sorry even to insinuate anything offensive against Mr. Hopkins, of whom I have no knowledge whatever, but I must state that he cannot be well informed on the subject of embankments on sands, in some of which, and of great magnitude, I have been myself engaged.	
There are very extensive embankments composed on sands of unlimited depth, and composed chiefly of the sands themselves, faced with a coat-	Such embankments are only extensive in regard to length. Can Mr. Hemans refer to any embankments 25 or 30 feet high, constructed in this

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Mr. Hemans' Letter.	*Mr. Hopkins' Observations in reply.*
ing of clay stones or fascines, as the case may be. Such embankments I have myself constructed, and others have done so to a much greater extent.	way, having a head of water of 20 feet to support, and placed in situations so exposed; and does he wish it to be understood that he proposes to form these embankments out of these sands themselves?
The term "quicksands" is, in fact, very delusive, and is to a great extent, in the sense used by Mr. Hopkins, "a bugbear." Quicksands are simply sands of a fine grained description, easily moved by water. When a wreck lies upon them on shoal ground, the eddies of the rising and falling tides draw away the sands, by rippling round the wreck, and the mass, of course, gradually sinks from losing its support.	The term "quicksands" is not more delusive than the sands themselves, and the sands in question are precisely of the character here described by Mr. Hemans.
Exclude the water, or keep it in the sands, and they will support any amount of weight.	Granted; but Mr. Hemans does neither one thing nor the other.
It is not, however, intended, as Mr. Hopkins imagines, to build the proposed embankments three or four miles out to sea or in situations where there will ever be nearly so much as 20 feet of water upon them. As regards the Dengie Flats, Mr. Hopkins's objection about quicksands does not apply at all.	Then it is not intended to carry out the works as laid down by Mr. Hemans on his own plans and sections. These show the proposed embankments two miles out to sea on the Ray Sands, from two and a half to three miles on the Foulness Sands, and from Foulness Point the new wall is to extend four miles out to sea, and if built in these situations there is no denying the fact that they will be in 20 feet of water, and Mr. Hemans' own sections show them so; surely there is nothing imaginary in stating what the promoters themselves show on their own plans and sections.
Foulness Island lies below the level of high tide, and, as Mr. Hopkins states, consists of a mere skin of soil over a depth of sand of 40 feet. It has been wholly reclaimed by moderate sized embankments from the sea, and yet the sands are obviously precisely the same as those outside the embankments, which latter, according to Mr. Hopkins' view, ought to have been swallowed up when first constructed.	The lands along the whole coast have been reclaimed from time to time by moderate sized embankments, and may continue so to be. I must here observe that Mr. Hemans seems to shut his eyes to the difference between reclaiming gradually with these "moderate sized embankments," as the soil is "warped up," and an attempt to reclaim by a gigantic scheme, placing, I must reiterate, his embankments in water 20 feet deep. Instead of "moderate sized embankments" formed near the coast-line, and protected by a foreshore three or four miles in width, the proposed embankments will be 20 times the size of the present, and have little or no foreshores, as they are situated near the outer edge of the sands not much above the level of low water, and there is no analogy between the two situations. It does not at all follow that the state of things described by Mr. Hemans in the latter part of his remark should have taken place. I may, however, state that even the present embankments, small as they are, settle down into the sands, and require to be added to from time to time.
2d Objection. Numerous channels and rills, draining off the fresh water, and admitting when required the tidal waters to the Dengie and Foulness coasts, are, Mr. Hopkins assumes, to be stopped up by our works to the great detriment of the internal lands. The simple answer to this is that nothing of the kind is intended. Ample provision will be made for existing outfalls, and for such new and improved ones as may be necessary.	My Report stated that the Dengie Flats were intersected by large water courses, which were outlets for the drainage of the main-land, I did not state, nor even assume, that these were to be stopped up; on the contrary, I said that "they could not be stopped up," the necessary consequence of which is that each of these channels must be embanked on both sides, and this will add very considerably to the length of sea-walls to be constructed. On the Foulness Sands there are no outlets; but there are seven inlets for supplying the interior of the island with water. These must also be maintained, and will be require to be embanked in the same manner.
3d Objection. That there are no materials to make the embankments with. The	Along the Essex Coast the embankments are generally made of the warped up soil after the "saltings"

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Mr. Hemans' Letter.	*Mr. Hopkins' Observations in reply.*
The answer to this is, that the whole of the existing embankments on the Essex and other coasts are composed of the mud or sands themselves *in situ*, in some cases protected with a mere facing of clay, or stones, or fascines brought from other places. Ample foreshores will be left outside the embankments to protect them.	"saltings" or salt marshes have been formed, faced as Mr. Hemans describes, but nowhere have they been constructed in such places or in such situations as Mr. Hemans now proposes; in addition to the protection of the facing, the present walls are protected with a foreshore, or breakwater, some miles in width; and I cannot conceive how Mr. Hemans can possibly have ample foreshores outside the proposed walls, the scheme being to reclaim the present foreshores by raising embankments at the outer edge of the sands near deep water.
Chalk for facing can be procured in large quantities cheaper than Mr. Hopkin's imagines, but on the Dengie Flats but little will be required.	The price I stated for chalk was not from imagination, but what is now actually paid for it. From this and the foregoing remark I think it fair to assume that Mr. Hemans intends to construct the embankments out of the sands themselves, facing those on Foulness with chalk, but not those on the Dengie.
Instead of three hours at each tide, it is expected that in the situations where the walls are to be erected, from five to six hours will be available; but a part of the work may be done entirely independent of the tides.	Then it cannot be the intention of the promoters to construct the embankment where shown on the plans, but much nearer the coast, and if so they will not enclose so great an area as 20,000 acres, and, consequently, not obtain so great a return for the capital expended.
4th Objection. That the only road into Foulness, that between Wakering Stairs and Fisherman's Head, will be entirely shut up. This road is only open at low water, but it is a most gratuitous assumption that it is intended to stop it up. On the contrary, the passage of that road over our embankment will be made perfectly good and easy. More than half of the road will, under the protection of our walls, be always high and dry, and available at all hours, whereas now it is only a track in the mud for a few hours at low water.	If the road is preserved, it is of course all that those interested in it can desire.
5th Objection. The sewage water is, Mr. Hopkins thinks, to lie on the 20,000 acres proposed to be reclaimed near Foulness, which surface being impregnated with salt water, cannot imbibe it and cannot be drained; consequently, all the neighbouring atmosphere will become offensive, and Foulness will be uninhabitable.	
I am much astonished at these assertions coming from one whom I presume to be a civil engineer. Is it a fact that the hundreds of thousands of acres which have been reclaimed from the sea in England and Holland, remain always "impregnated with salt?" Is it a fact that "they cannot be drained?" Mr. Hopkins must surely be aware that salt rapidly disappears, owing to the action of rain and sweet waters, after the exclusion of the tides from the reclaimed land; and, as to drainage, why cannot gravitation carry off the inland and salt waters as well as through our embankments (as far as the fall allows), as it does now through all the existing embankments on the coast? But by what right is it assumed that no mechanical steam or wind drainage is intended in aid of gravitation? Is not such aid employed most economically over vast districts? What, then, does Mr. Hopkins mean by saying that our particular inclosures cannot be drained? The real intention is not to let the sewage lie on the soil, but to draw it through by drainage, and to discharge only clear water into the sea.	Before expressing his astonishment, Mr. Hemans should be careful not to misunderstand what I said. Reclaimed land does not, I admit, remain impregnated with salt water; but I was not speaking of reclaimed land, I was speaking of the existing sands, and before these can receive the sewage the salt water must be drained from them. Mr. Hemans speaks very lightly of this, but as the proposed embankments are near low water, the outlets for draining the reclaimed space will be also near low water, and this will make the use of some of the appliances Mr. Hemans alludes to not only a probability but a necessity. But will Mr. Hemans allow me to ask him whether he is quite sure that with a head of water of 20 feet outside his embankments the salt water will not find its way through the sand under the proposed embankments, and keep the land to be reclaimed saturated; he must bear in mind that to counteract the 20 feet of water outside, he has no warped up soil inside, but only a thin film of sewage spread over the surface, and it is very questionable whether the drainage of these lands in readiness to receive the sewage is so easy as he imagines. He would doubtless reply by his favourite argument, and ask me why the salt water does not find its way under the present embankments and impregnate the land inside; but the reason why it
6th Objection.	

Mr. Hemans' Letter.	*Mr. Hopkins' Observations in reply.*
	does not is evident; there is, at high water, only a head of 3 feet outside the present walls, and the 3 feet of soil on the island is more than sufficient to counteract the weight of this, and is a very different thing to 20 feet of water outside, and nothing inside to counterbalance it.
6th Objection. Mr. Hopkins goes into theories of the effect of the abstraction of tidal waters, and the dangerous velocities to be caused by us in the River Crouch, the embankments along which are to be destroyed, according to him.	I said nothing of the sort. What I said was, that "they would be injured by the increased velocity of the tidal waters running up the Crouch, and it might be found necessary to strengthen them." If, unfortunately they should give way, thousands of acres would be laid under water, and a greater extent of country damaged than the Essex Reclamation Company are ever likely to be able to reclaim.
He adds that all the sailing channels will be disturbed, and that the Admiralty will never consent to such embankments.	Of which there can be no doubt; reference to a chart of this part of the sea will preclude the notion of any other conclusion; and the Admiralty Inspector in 1852, in a report, to which I shall presently refer, stated that the then proposed works were dangerous to the entrances of the Crouch and Blackwater. As the present works are very similar to the works then reported on, I apprehend the consequences will not be dissimilar.
What right Mr. Hopkins has to pledge the Admiralty, I cannot imagine. He will, I suppose, be surprised to learn that the Admiralty did approve of very similar embankments on the same sands in the year 1852, and that, having laid the present project before them, Mr. Napier and myself had the honour to receive the full approval of the reporting officer, who only suggested a slight alteration in one of the lines, and who stated his opinion that the works would be highly beneficial to the entrances of the Crouch and Blackwater.	If Mr. Hemans will refer to the report of the Admiralty Inspector, Mr. Lewis D. B. Gordon, on the scheme of 1852 (which report was approved by the Admiralty), he will find that, instead of approving it, he reported very strongly against it; and I would advise every one interested in this question to read that report, as much of what is therein stated applies to the present scheme; and if the Admiralty afterwards consented to the scheme, at all events clauses were inserted in the Act of Parliament, in the face of which I will undertake to say Mr. Hemans would hardly venture to recommend any company to proceed with their works (*See* Clauses 34 to 39 inclusive, 15 & 16 Vict. c. 66).
	When Mr. Hemans asks what right I have to pledge the Admiralty, I would ask him whether he expects for one moment that Parliament will pass an Act sanctioning this, or any other scheme having the same object, without inserting similar clauses? And when he points triumphantly to the fact of the Admiralty having approved of very similar embankments on the same sands in 1852, does he forget that the clauses which the Admiralty had inserted were of such a nature that 10 years have elapsed without any portion of the works being carried out, or any probability of their being attempted, a state of things which it is just possible might befal the scheme to which Mr. Hemans is engineer, were the Company so fortunate as to obtain the Act of Parliament.
I think, sir, it is needless to combat further at present the assumed difficulties raised by Mr. Hopkins, but I cannot conclude without expressing my astonishment that Mr. Finch, the proprietor of the 6,000 acres of Foulness Island, should be advised to oppose a project which must become, if carried out, in the highest degree beneficial to his property.	I happen to know that without any advice, Mr. Finch has his own reasons for objecting to this scheme (as he did to the scheme of 1852), thinking that it would neither be beneficial to his property, to the surrounding neighbourhood, or to the Company: his opposition is not based on my report, but dates from a period long antecedent. So far from looking on the contemplated project of the promoters as a boon, he considers it will be injurious and very objectionable, and cannot persuade himself to indulge in the pleasing prospect of quadrupled rents, rich farms, &c., &c., &c., which Mr. Hemans indulges in with such rapture.
We propose to carry to his broad acres of thin, dry, and shallow land, an inexhaustible source of the richest liquid manure, the judicious use of which would probably quadruple his rent, and change the whole character of the neighbouring country into a highly fertilized soil.	
His embankments would be secured and protected by new ones far outside the present ones, which	

Mr. Hemans' Letter.

which he would not have to keep in repair. Instead of the desolate sands, covered at high tides, he would have rich farms between him and the sea, while a busy population would be engaged on the large estates of the Reclamation Company, whose presence must enhance the value of land and produce on all that part of the coast.

All the coast lands from the River Blackwater to the Thames are deficient in fresh or rain-water depth of soil and manure. We offer what is equivalent to all these wants, both to the existing lands and to the lands we propose to reclaim. It does appear extremely short sighted to oppose what ought to be sought for as an incalculable benefit.

I have, &c.
(signed) *G. W. Hemans.*

J. Pollard, Esq.,
Clerk to the Honourable Board of Works,
Spring-gardens.

Mr. Hopkins' Observations in reply.

In conclusion, I may state that Mr. Hemans does not attempt to deny the nature of the sands he has to deal with, nor can he, unless he is prepared to contradict his own plans and sections, deny the intended situation of the embankments, or the depth of water he will have to contend with; as to materials, we have, it appears, the sands themselves to form the embankments, with little or no foreshores to protect them; he cannot deny the exposed situation of the works, and the time for carrying these on is not a matter of opinion but a matter of fact, and the nuisance can hardly be doubted. Whatever difference of opinion there may be about other things, there can be little or no difference about these.

The question of cost and remuneration I have not entered into, as, in the absence of Mr. Hemans' details of the proposed works, the consideration would be attended at the present time with little or no profit.

I have, &c.
(signed) *George Hopkins.*

21, King's College-road, Hampstead,
Gentlemen, 26 June 1863.

When your Board was first formed, in Greek-street, Soho, I waited on your Chairman, who received me courteously, and, after explaining to him the nature of the enclosed drawing, I was referred to Mr. Bazalgette, who said it was not in accordance with their present plans.

Learning from public prints that you intend to adopt and work out some plan of utilising the sewage of London, I take the liberty of renewing my proposal, and beg to call your attention to it. I have made the health of towns my study, and find the following difficulties must be overcome:—

1. The unhealthy effluvia that rises from the drains of all houses.
2. The disgusting smell from gully holes in the streets.
3. The filthy state of leaving mud at the sides of streets, and annoyance of scavengers.
4. Filthy and dirty streets in wet weather.
5. The nasty smell of gas when ground is opened.
6. The possibility of gas mixing with the water of the metropolis.

I beg leave to say that I can prevent all these, and could reap a large revenue, and if you give me encouragement I will send in my plans, the practicability of which could be proved in one month.

The labourer is worthy of his hire, but I do not want my brains to be sucked for the advantage of others.

I have, &c.
(signed) *A. Cochrane*

To the Chairman and
Gentlemen of the
Metropolitan Board of Works.

Gentlemen, London, 14 July 1863.

In the "Morning Star," July 13th, 1863, is mentioned that the Chairman has received several tenders for taking the sewage of the metropolis. The sewage question has become one of great moment and serious consideration. Will you allow me to state that there is a method by which all the sewage, manure, and cesspools, &c., may be rendered perfectly innoxious, and at the same time retain the virtues and principles required for tillage. The present sewers will be amply sufficient. The plan proposed will repay a great dividend upon the money spent, and ultimately repay the whole capital laid out: all plans at present brought under your notice have proved ineffectual to render the immense filth in London sewers, cesspools, &c., innoxious. The focus of pestilence engendered in the sewers, &c., is of magnitude sufficient to contaminate all the surrounding waters and districts; there

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there corruption engenders, and is closely connected with putresency; we are all aware that putresency is considered the chief source of pestilential maladies; we should therefore enforce salutary laws, and embrace every opportunity offered for destroying all noxious vapours, and thus avoid the frequent scourges that visit our homes and cities. If this mass of sewage be dischagred in the Thames, either in Barking Creek (as once proposed) or elsewhere, instead of being made into manure (which can be easily done) and manure, too, of immense value, computed to be between 4,000,000 *l.* and 5,000,000 *l.* (and of that has been stated at least 1,000,000 *l.* would go to the ratepayers of London) why should this sewage be flying away, when it is required for fertilising purposes, and would add to the wealth of the nation? If the manure manufacturers join the Sewage Company they would become one of the most wealthy companies in the world. The writer will undertake, under certain arrangements, to disclose at present an unknown secret, so that all may derive benefit, both by manure and sewage, and destroy all noxious vapours arising therefrom, improving the quality of the manure, &c., and it may if requisite, be carried openly through the thoroughfares without offence to any one.

May the writer hope that attention be paid to this subject now offered to your and the nation's benefit.

I shall be happy to communicate at greater length, if requisite, upon the facts above stated.

Allow me, &c.
(signed) *M. Booth.*

To the Metropolitan Board of Works,
Spring Gardens.

REPORTS by the OFFICIALS of the BOARD or the MAIN DRAINAGE COMMITTEE upon the said PLANS or proposals.

METROPOLITAN BOARD OF WORKS.

ESSEX Land Reclamation and Metropolitan Sewage Irrigation Company.

Engineer's Department, Spring Gardens, S.W.,
31 December 1861.

IN pursuance of the orders of the Main Drainage Committee of the 12th November last and the 10th instant, I have considered the engineering features and estimates of the works contemplated in the proposition submitted to this Board by the Honourable W. Napier and Mr. W. Hope, V.C., for a concession of the sewage of the northern area of the metropolis for a period of 50 years upon certain conditions, to be approved by the Board.

These gentlemen propose by sea embankments and a system of warping, to reclaim about 20,000 acres of land from the Foulness Sands and Dengie Flats on the Essex coast, and to render these tracts productive by irrigating them with the 10,000,000 cubic feet of sewage produced daily from the northern metropolitan area.

To convey the metropolitan sewage to the reclaimed lands, it is proposed to construct a brick culvert 10 feet in diameter from the main, intercepting sewers at Abbey Mills pumping station to the river Crouch, a distance of 37 miles, whence two open branches, each seven or eight miles in length, diverge and convey the sewage upon the reclaimed lands. In the line of the brick culvert is to be a lift of about 30 feet, with a pumping establishment of about 1,000 H.P.

Parliamentary plans have been prepared and deposited by Mr. G. W. Hemans, engineer to the project, and it is proposed upon obtaining from this Board the anticipated concession of the sewage to form a company, raise a capital of 2,000,000 *l.*, and apply to Parliament for powers to execute the works.

The tract selected appears to be well adapted to the reception of the sewage, and is indeed the only one yet suggested to the Board, where from its position, extent, and the nature of its soil, there would be a reasonable prospect of its receiving advantageously so large and constant a discharge of sewage without creating a nuisance to the surrounding district.

As it is proposed to carry off the sewage only, without the rainfall, the intercepting outfall now in course of construction to Barking would still come into partial operation during seasons of rain, and into full operation in case of any accident or failure of the contemplated works, and possibly during seasons of continued frost. It would, therefore, not be desirable on account thereof in any way to alter the design of the main drainage works; but the immediate advantage gained to the metropolis would be that instead of the sewage being discharged daily into the Thames at Barking Creek, it would be entirely removed from the Thames, and the proposal would obviate the possible cost of ultimately deodorising at Barking during the hot seasons.

In the course of my investigation I have been supplied with detailed drawings and estimates of the proposed scheme, and I find that the works have been carefully considered and well designed, and the estimate is fair and sufficient.

This proposition is the only one the promoters of which have, by depositing plans, placed themselves in a position to carry out during the coming Session of Parliament, and so far as its engineering character and details are concerned, it is thoroughly practical, and deserves the favourable consideration of the Board.

(signed) *J. W. Bazalgette.*

To the Main Drainage Committee.

Solicitor's Department,
Spring Gardens, S.W.,
1 January 1862.

I HAVE considered the Bill called the Metropolis Sewage and Essex Reclamation Act 1862.

The Premable recites the advantages of the measure and clauses 1 to 15 relate to the incorporation of the Company and usual matters of regulation of shares, meetings, &c. Section 16 empowers the Company to embank the reclaimed lands shown on the plan. Sections 17 to 31 regulate the works and period for embankment (14 years), the diverting creeks, making roads, &c., and providing for consent of the Admiralty &c. and keeping open channels, &c.

Sections 31 to 35 relate to the works being extended to the sea, and to the regulations for answering the claims &c. of the Commissioners of Sewers.

By section 36 the land when reclaimed is to be vested in the Company but not to affect the interest of private persons.

Section 37 and several following prescribe the division of the embankment into parishes &c. by consent of the Crown, and appointing commissioners to maintain the bank.

Clauses exist for appointing officers at salaries, and a rate is to be made on the reclaimed lands to pay the expenses.

There are miscellaneous clauses enabling the Company to irrigate the lands, to let and even sell the reclaimed land. (Section 52.)

There are clauses enabling the Company to construct conduits (including that from the Pumping Station of this Board).

By Section 57 the Company and Board may enter into contracts for removing by the conduits the sewage from the north side of the Thames, and the communications are to be made to the satisfaction of the engineer of this Board, but if the engineer of the Board and Company differ, then by an engineer to be appointed by the Board of Trade.

Other clauses (58 and 59) empower the Company to use the sewage for the reclaimed lands, and by Section 61 the Company is (subject to the above) to intercept all the sewage which by any contract with this Board they may be entitled to take.

The Bill saves the right of the Crown.

The particular attention of the Board will be necessary to the 135th section of the Metropolis Local Management Act, and the 23rd and 24th sections of the Metropolitan Local Management Amendment Act. The Bill binds the Company to nothing, neither is there yet a company, and any contracts are to be as may be mutually agreed on only. (*See* section 57.)

(signed) *W. W. Smith.*

EXTRACT from a REPORT of the Committee of the whole Board on the Main Drainage of the Metropolis.

1, Greek-street, Soho Square,
17 January 1860.

* * * * * * * * *

THE Board on the 25th February last (No. 32) having referred it to your Committee to consider the proposition submitted by Mr. Roberts on behalf of the London Sewage Utilisation Company relative to the employment of the London sewage, and having authorised your Committee to confer with the parties, your Committee have now to report that they have considered the proposition and conferred with Mr. Roberts, and ascertained that the proposed mode of dealing with the sewage is to apply it to the irrigation of grass lands by means of iron mains with branches to the various plots proposed to be dealt with, that the material parts of the proposition ultimately submitted to your Committee were that the Board should grant to Mr. Roberts, or to any person, company, or partnership, to be nominated by him, so much of the sewage on the north side of the Thames as would be conveyed through the main outfall channel as the parties might require at Barking Creek, and be able to employ for a term of two years at an annual rent of 5 *l.*

That should the parties at the end of two years be able to apply the sewage with commercial advantage, the Board to grant such of the sewage on the north and south sides (except the sewage from the western district) as the parties may require for 21 years, and after that period for a further term, on their undertaking to pay such rent or royalty as may be agreed upon between the Board and the parties, and in case of difference the question to be determined by the president of the Society of Civil Engineers or by the Board of Trade.

That the arrangement be void at the expiration of six calendar months, unless within that period, a company or partnership be constituted.

Your Committee have carefully considered the proposition, and fully discussed the matter, and are of opinion that some arrangement on the basis of the said proposition might with advantage to the Board be adopted. Your Committee therefore submit, for the consideration of the Board, the propriety of entering into an agreement containing the following stipulations:—

The Board to concede the sewage conveyed by the main-drainage channels for a preliminary term of two years.

That in consideration of the large outlay to be incurred by the parties and the great commercial risk attending their operations.

That the Board consent to grant the use of the sewage for a period of 21 years at a nominal rent of 5 *l.* per annum, subject to stringent conditions for guarding against nuisances, and for indemnifying the Board against costs and expenses.

And, at the expiration of the first 21 years, to grant a further extension or term of 21 years at a rent, to be mutually agreed upon; or, in the event of disagreement, the amount to be decided by a competent tribunal to be specified, subject to the most stringent covenants for preventing nuisance, and indemnifying the Board against costs and expenses.

Your Committee may remark that the proposition received from Mr. Shepherd for taking the sewage for the term of 100 years, was also referred to them for consideration, that they invited that gentleman to attend before them for the purpose of ascertaining the features of his scheme, but that in consequence of illness, he was unable to be present. Your Committee are not, therefore, in a position to lay before your Honourable Board a statament of the nature of his plans.

* * * * * *

(signed) *J. Thwaites.*
John Savage.
James Pew.

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REPORT of the Committee of the whole Board on the Main Drainage of the Metropolis.

1, Greek-street, Soho, 24 April 1860.

THE Board, on the 27th January last (No. 4), having referred it to your Committee to prepare a form of advertisement inviting tenders from parties who may be willing to treat with the Board for taking the sewage of London, your Committee have to report that they have caused the following form to be prepared which they now beg to submit for the approval of the Board.

CONTRACT for the Sewage of the Metropolis.

THE Metropolitan Board of Works hereby give notice that they will meet at the Council Chambers, Guildhall, in the city of London, on Friday, the day of at 12 o'clock at noon, and will be prepared to receive and consider tenders or proposals from any parties who may be desirous of contracting for deodorising or otherwise treating the sewage conveyed by the main outfall sewers of the metropolis, so as to render the same innoxious, or for removing and disposing of such sewage with a view to its application to agricultural or other purposes.

Parties who may wish to submit tenders or proposals to the Board, may obtain plans showing the points at which the sewage will be delivered or may be taken, with particulars of the estimated quantities at the several points and other information, on application to Mr. J. W. Bazalgette, engineer of the Board, at the office of the Board, No. 1, Greek-street, Soho, before four o'clock, on Thursday, the day of upon payment of the sum of 1 *l.*, and any tender or proposal sent in after that hour will not be received.

The tender or proposal may have reference to all or any of the points of outfall indicated on the plan, and each tender or proposal must contain an explicit description of the proposed mode of dealing with the sewage, and stating the terms offered for the use of it, the parties intending to contract, the amount of capital which will be invested in the works, the duration of the contract, and such other particulars as shall render the proposal intelligible.

Any party with whom the Board may decide upon contracting, will be required to enter into a contract, containing amongst others, covenants for taking the whole of the sewage contracted for, at such points and localities as may be sanctioned and approved by the Board for effectually removing and disposing of the sewage, and for making the requisite communications and executing all other works or matters which may be necessary for carrying on the operation of the contractor at his own cost and expense, and also covenants for taking and disposing of the sewage and conducting all operations in such a manner as not to create a nuisance, and so as not to contravene the provisions relating to nuisance and other matters contained in the "Metropolis Local Management Act, 1855," the "Metropolis Local Management Act Amendment, 1858," or any Acts which may be passed for amending the same and for subjecting the contractor to penalties in case of non-compliance with the contract, and also for enabling the Board, in case of nuisance, to revoke the permission granted and determine the contract without compensation to the contractor for loss or damage or on other grounds.

The Board do not bind themselves to accept any tender or proposal, and the party whose tender may be accepted will be required to provide two approved sureties to be bound jointly and severally in the sum of 5,000 *l.* for the due performance of the contract.

Clerk of the Board.

All which your Committee have to submit.

(signed) *J. Thwaites.*
Thos. D'Iffanger.
Fred. Doulton.

EXTRACT from the REPORT of the Committee of the whole Board on the Main Drainage of the Metropolis

1 Greek Street, Soho,
1 May 1860.

THE Board on the 9th December last (No. 84) having referred to your Committee for consideration and report the letter from Mr. G. E. Shepherd, stating that he was prepared on certain terms set forth in the letter, to enter into negotiations with this Board for the use of the whole of the sewage of London for a term of 100 years, your Committee have accordingly proceeded on the reference, and have received from Mr. Shepherd further communications on the subject, Since the above reference was made to your Committee, however, your Honourable Board have directed the issuing of advertisements inviting tenders from parties who may be willing to take the sewage. Your Committee have, therefore, communicated with Mr. Shepherd to that effect, and deem it unnecessary to proceed further in the matter.

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(signed) *J. Thwaites.*
James Pew.
Edward Shepherd.
Thos. D'Iffanger.

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METROPOLITAN BOARD OF WORKS.

REPORT of the Committee of the whole Board on the Main Drainage of the Metropolis.

Spring Gardens, 1 January 1862.

YOUR Committee have to report that in obedience to the resolutions of your Honourable Board of 6th July 1860 (No. 8) and 22d March last (No. 63) they have considered the tenders for taking the sewage of London, together with the communications addressed to the Board on the subject.

It may be convenient to describe briefly the more material points of the several propositions and communications which are referred to your Committee.

The Directors of the London Sewage Utilisation Company propose to take so much of the sewage from the outfall sewer on the north side of the river as they shall require and be able to employ for a preliminary term of two years at a rental of 5 *l.* per annum, and on the expiration of such term, if the Company should desire it, that the Board should concede to them all such sewage conveyed by the outfall sewers on both sides of the river (except the western district sewage) as they shall require for a term of 21 years from the expiration of the preliminary term before-mentioned, at a rental of 5 *l.* per annum; that at the end of such 21 years, if the Company should require it, the Board shall grant them an extension of the term at a rent or royalty to be agreed upon, and that in estimating the amount thereof, and the length of the extended term, regard shall be had in favour of the Company to the originally speculative nature of the undertaking and to the outlay thereon. The Company also propose to reserve to themselves the right of relinquishing the sewage at any time, on giving to the Board two years' notice to that effect.

The propositions made by Mr. John James Moore embrace the taking of the whole of the sewage of the metropolis for its application to agricultural purposes for a term of 90 years, or other reasonable period, the Board receiving a nominal or peppercorn rent for the first 14 years; and at the expiration of that time one half of the profits which may be derived from the sale of the sewage, after deducting 10 per cent. on account of the capital invested, or such reasonable return as may be awarded by arbitrators to be appointed by Her Majesty's Secretary of State.

Mr. George Shepherd proposes, on behalf of a Company to be formed, to take the sewage of London for agricultural purposes for a term of 50 years: in the first instance the Company to be entitled, out of the revenue arising from the sale of the sewage, on all occasions to a preference of 7½ per cent. per annum on the capital employed; that all proceeds beyond such per-centage shall be equally divided between them and the Board; and that at the expiration of the 50 years the Company shall receive a preference of 5 per cent. on their capital, the surplus being divided as before.

Mr. Charles F. Kirkman merely states that he has devised a plan for deodorizing and utilising the sewage to its fullest extent, and will be prepared to submit to the Board a description of such plan, if an adequate remuneration be secured to him for it.

The propositions made by Mr. Ellis, on behalf of a Company to be formed, are:—That the Company shall take the sewage of London from the reservoirs at the outfalls, and raise it by pumping to elevated positions on both sides of the river, with the view to distribute it from thence for agricultural purposes; the sewage, previously to its application to the land, being freed from offensive smell, if so required by the Board; that the Board shall be empowered at any time to have the power of suspending the further distribution of the sewage, if found likely to cause a nuisance; that in the event of accident to the machinery, or from any other cause, the Company should be unable to apply the whole or any portion of the sewage to the land, they should be empowered to pump the same into the river, having previously deodorized and precipitated it; that from the revenue derived from the sale of the sewage, the Company shall receive a preference dividend of 5 per cent. on the amount of their paid up capital, the remainder of the revenue being divided between them and the Board; that the management of the Company be vested in a Court of Directors, one half of such Directors being elected by the shareholders, the other half being nominated by the Board from their own body; and that the Board shall concede the sewage to the Company in perpetuity, or for such term as they have power to grant. Mr. Ellis has furnished your Committee with additional explanations on the subject of his propositions, and has also laid before them estimates of the cost of the necessary works, the working expenses, and the anticipated revenue.

Your Committee have also had before them communications from the Honourable William Napier and Mr. Hope, Vice-Chairman, on behalf of a Company about to be formed for taking the dry-weather sewage of the northern area of the metropolis; from which it appears that it is contemplated to reclaim certain tracts of land on the Essex coast, to the extent of about 20,000 acres, and to render them productive by irrigating them with the sewage. The cost of the works for carrying out the plan is estimated at 2,000,000 *l.*; and it is intended to incorporate a Company under an Act of Parliament for the subscription of the capital and the working of the scheme, should the necessary grants of the land and the sewage be obtained from the Crown and this Board. The propositions made to the Board on behalf of the proposed Company are as follows:—

The grant of the sewage to be conditional on the ratification by Parliament of the grant by the Crown of the land upon which it is proposed to operate.

The right of the Company to the sewage to be absolute and exclusive for a period of 50 years, commencing from such time as may be fixed upon by the Board, and sanctioned by Parliament for the completion of the works.

The works of the Company to be capable of taking the ordinary dry-weather discharge, as estimated by the officers of the Board at 10,000,000 cubic feet per diem.

All net profits realised by the Company, in excess of 10 per cent. on their total outlay, to be equally divided between the Company and the Board; such profits to be verified by the Company's auditors, in conjunction with an auditor to be appointed by the Board of Trade. Should the net profits in any year, within five years after the completion

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In the event of the Company making sales of the land and realising more than the original cost of their whole works, together with the stipulated 10 per cent. per annum, all profit over and above the sum thus standing at debit on the books of the Company to be divided between the Company and the Board. All money realised by such sales of land to go to the credit of the capital account of the Company.

On giving seven years' notice, the Board to have the right to take over, at the expiration of the grant of 50 years, the whole of the Company's works and land at a valuation, such valuation in no case to be below the total original cost as passed by the Auditors above mentioned. In the event of the Board not wishing to exercise this right, a new concession of the sewage to be granted to the Company for 50 years on the same terms.

The Board to be represented in the management of the Company by two Directors, who shall have all the powers of ordinary directors, with the same fees.

Your Committee have inspected a plan showing the lines of culvert to be constructed for the conveyance of the sewage to the lands to be irrigated, and have also received verbal explanations from Mr. Hope, and Mr. Hemans, the engineer of the promoters, as to the nature of the scheme and the revenue expected to be derived therefrom. A more detailed description of the operations intended by the Company will be found in the communications from the Honourable William Napier and Mr. Hope, which have, by direction of your Committee, been already circulated amongst the members of your Honourable Board.

Your Committee, in deliberating on the various propositions, have been mainly guided by the fact, that two very material points were necessary to be secured, the first, the absolute necessity for guarding the Board against the consequences which would arise in the event of a nuisance being created by the application of the sewage; and the second, the desirability of adopting, if possible, a scheme which should hold out a prospect of some benefit in a financial point of view, ultimately accruing to the ratepayers of the metropolis. These objects are, in the opinion of your Committee, more likely to be effectually attained by the scheme propounded by the Honourable William Napier and Mr. Hope than by either of the others which have been submitted to your Honourable Board.

The promoters of that undertaking have complied with the Standing Orders of Parliament as to the deposit of plans, &c., and have made arrangements for prosecuting a Bill, during the coming Session, for enabling them to carry out their proposal. Your Committee have conferred with your engineer on the practicability of the scheme, and the sufficiency of the estimates for the works, and he is of opinion, after examining the detailed drawings and the estimates, that the works are well designed, and the estimates fair and sufficient. Your Committee have also considered the Draft Bill prepared by the promoters. It may be proper to observe, that the question whether the Board are empowered under the provisions of their Acts, to enter into an arrangement of the nature now under consideration, is not free from doubt; but as the Bill will require modification in order effectually to secure the interests of the Board, that point can be provided for during its passage through Parliament. Your Committee beg to submit a copy of the reports of your solicitor and engineer with reference to the scheme and the Draft Bill, which reports have, by direction of your Committee, been printed and a copy supplied to each member of your Honourable Board; and they also beg to submit a copy of the Parliamentary plans deposited by the promoters.

Your Committee being fully impressed with the great importance of the subject entrusted to their consideration, have devoted considerable time and careful attention thereto, and have arrived at the conclusion that it is desirable your Honourable Board should entertain favourably the proposition for dealing with the sewage of the northern area of the metropolis contained in the communications from the Honourable William Napier and Mr. Hope, and that they should assent to the principle of a concession of the sewage of that area for a term of 50 years, provided the requisite authority be granted by the Legislature for that purpose, and subject to the introduction of all necessary clauses in the Bill for the protection of the Board, and of the public interests confided to them, and for ensuring the fulfilment by the Company of the obligations undertaken by them.

It is essential, in order to enable the promoters to proceed with their arrangements, and to deposit the amount required by the Standing Orders of Parliament, that your Honourable Board should, without delay, come to a decision on their propositions, and with that view, your Committee submit their report in order that it may be entered on the Minutes of the Proceedings of the Board; and they suggest that your Honourable Board should defer the further consideration thereof until their meeting on the 10th instant, and in the meantime each member will, no doubt, avail himself of the opportunity thus afforded of possessing himself of the information contained therein.

All which your Committee beg to submit.

(signed) *J. Thwaites.*
Josiah Wilkinson.
J. S. Phillips.

REPORT of the COMMITTEE of the whole Board on the Main Drainage of the Metropolis.

Spring Gardens, 29 July 1863.

YOUR Committee have to report that, in compliance with the resolution of your Honourable Board of 10th instant (No. 4), they have considered the several propositions for taking the sewage of the metropolis which have been made to your Honourable Board in reply to their advertisements. They find that nine communications have been received, that none fully comply with the terms of the advertisements, and that three do not make any proposals of the nature of a tender. As the subject is one which has already seriously occupied the attention of your Committee, it may be convenient to remind you that in April 1860, you directed them to prepare a form of advertisement, in answer to which, tenders were received and opened on 6th July 1860, from Messrs. Townsend, Moore, and Shepherd, expressed in nearly the same terms as their appended communications.

The names of the parties who have replied to the recent advertisements are as follows:—

Dr. Thudichum, 2, Pembroke-road, Kensington.

Mr. David Curwood, 18, Upper Grosvenor-street.

Lord Torrington, Sir Charles Fox, and Mr. Hunt, 8, New-street, Spring Gardens.

Mr. John James Moore, 6, Pump-court, Temple.

Mr. George Townsend, Secretary to the London Sewage Utilization Company (limited) 18, New-street, Spring Gardens.

Mr. George Shepherd, 26, Throgmorton-street.

Mr. C. F. Kirkman, 6, Duke-street, Adelphi.

Mr. Thomas Ellis, 76, Warwick Square, Belgravia.

The Hon. W. Napier and Mr. Hope.

Dr. Thudichum, M.D., proposes by a mechanical arrangement so to separate the house drainage as to retain that which he considers most valuable, and gives a sketch of his closet and drains, and tables of analysis of the constituents of fluid sewage. He estimates the cost of the works for carrying out his process at 1,500,000 *l.*, and the net profit at 1,000,000 *l.* per annum; of this, he proposes that he should receive a per-centage, and that one-half of the balance should be paid to the Board, and one-half to the Shareholders of a Company to be formed for carrying out the system.

Mr. David Carwood is not in a position to offer a tender, but suggests the separation of the solid and liquid sewage.

Lord Torrington, Sir C. Fox, and Mr. Thornton Hunt, regret their inability to comply with the conditions of the advertisement, on the grounds of the impolicy of publicly declaring the land with which they propose to deal; but express their willingness to discuss the matter with the Main Drainage Committee, and to enter into a provisional arrangement for prosecuting a Bill in Parliament during the ensuing Session.

Of the remaining six, three refer to their previous communications responding to the Board's advertisement in April, 1860, as embodying the propositions they have to submit; these are Mr. Moore, Mr. Townsend, on behalf of the London Sewage Utilisation Company, and Mr. G. Shepherd.

The first two are printed at length at pp. 488, 489 of the Minutes for 1860.

The proposals of the London Sewage Utilisation Company had been previously reported on by the Main Drainage Committee, 17th January, 1860.

These were that the Board should grant the Company as much sewage as they might require at Barking Creek for two years at a rent of 5 *l.* That should the experiment be successful, the Board should, at the end of those two years, grant a further term of 21 years at the same rent; and at the end of such term, that the Company should pay such rent for such further term as might be agreed between the parties, or as might be determined by the arbitration of the President of the Institute of Civil Engineers or by the Board of Trade.

The proposals of Mr. Moore were that the Board should grant the sewage for a term of 90 years, the first 14 at a peppercorn, and at the expiration of that term one-half the profits, after deducting 10 *l.* per cent. interest on the capital invested, or on such reasonable return as the Secretary of State might award to be paid by the grantees to the Board.

In a further communication, 9th July 1863, Mr. Moore offers to pay one farthing per ton for every ton of sewage raised by the Board to a height of 200 feet, which at 80,000,000 gallons daily would, he estimates, amount to 136,000 *l.* per annum.

Mr. Moore states that he has already engagements with the occupiers of nearly 60,000 acres for the use of the sewage.

Mr. Shepherd, in answer to the Board's advertisement, adheres to the proposals made in his former letters, and states that he will shortly be in a position to lay before the Board plans for applying the whole of the sewage; that on obtaining a concession, he will apply to Parliament for the necessary powers, and he asks for a concession of that of the south side first.

Mr. Shepherd's letters extend from January 1860 to the present date, but only two communications are of the nature of tenders. The first, dated 21st April 1860, asks for a concession of the whole of the sewage of London for 50 years, and offers to divide with the Board the net profits received by the Company, after paying 7½ *l.* per cent. on the invested capital after 50 years, the Company only to deduct 5 *l.* per cent. interest on their capital. The second, dated 4th July 1860, refers to the former tender, but requests that the concession should be full and free, without let or hindrance on the part of the Board.

There remain three communications purporting to be tenders in answer to the Board's advertisements.

Mr. Kirkman embodies a patent, of which he is the patentee, for obtaining manure from sewage by filtration and deposit, the water, after such treatment, to be discharged into the river. He proposes to erect works for this purpose at Barking, on condition that the Board shall convey to him the necessary land adjoining the reservoir, shall deliver the sewage to him from the main outfall sewer into his works, shall grant him the use of their river frontage and wharves for the term of seven years at a peppercorn, seven years at a rent of one-fifth the net profits, after deducting a dividend of 20 *l.* per cent. on the capital expended, and for a further term of seven years at a rent of one-fifth the net profits, after deducting 5 *l.* per cent. on the capital, and for any further term at such rate as shall be settled by the Secretary of State. Mr. Kirkman states that he is prepared to guarantee a minimum rent of 10,000 *l.* per annum, and he undertakes to name two or more securities for the performance of the contract. He consents also to surrender the works on two years' notice, subject to the repayment of the capital invested, and of a premium of 25 *l.* per cent. thereon, and to a royalty of 1 *l.* per cent. for the use of his patent.

Mr. Ellis proposes to pump the sewage from the Board's reservoirs to certain covered tanks constructed at such points as the Board may approve on either side of the Thames, from which it will

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will be allowed to flow by gravitation through pipes laid along the sides of the roads adjoining the area to be irrigated, which is also to be approved by the Board.

Mr. Ellis, on behalf of the Company to be formed, undertakes to provide and use all necessary deodorising agents, and to subject himself in all things to the directions of the Board; he further offers to submit the Act of Incorporation for the Board's approval. The net profits, deducting working and management expenses and reserve fund, he proposes to divide equally between the Company and the Board, and he suggests that three of the directors should be nominated by the Board.

The concession of the sewage he requires should be in perpetuity, subject to the Board's power to purchase after fifty years, on giving three years notice of the price to be fixed by valuers chosen jointly.

Messrs. Payne, Eddison, and Ford, undertake to pay 60,000 *l.*, to the credit of Mr. Ellis, local trustee, on his obtaining the concession of the sewage on satisfactory terms.

Messrs. Napier and Hope propose to intercept the whole of the ordinary flow of the northern sewage near Abbey Mills, and to convey it by a culvert 44 miles in length to Maplin Sands on the one hand and Dengie Flats on the other. Both these areas are at present submerged at high water and their redemption is part of the project, extending to 15 or 20,000 acres.

The capital proposed to be invested is 2,000,000 *l.* the concession of the sewage to be for 50 years, subject to Parliamentary authority being obtained, and to a grant of the land from the Crown. The net profits to be divided equally between the Company and the Board after a deduction of 10 per cent. on the outlay. The Board to have the power of resuming the grant of sewage and taking the whole of the land and works at a valuation, at the end of the term of 50 years, on giving seven years' notice or a new concession to be granted on terms to be settled by the Secretary of State.

The Board to be represented by two Directors of the Company. The Company to be formed within two years after obtaining Parliamentary powers. The Company within three months of its formation to pay into the hands of trustees chosen jointly a sum of 25,000 *l.*, India five per cent. stock, interest to be paid to the Company until three-fourths of the works are complete, the whole to be forfeited to the Board if the Company abandon the enterprise before three-fourths are completed.

Your Committee have thought it desirable, for the information of your Honourable Board, to append to this report the several tenders which have been from time to time made to the Board for taking the sewage of the metropolis, together with supplementary documents and explanations of such tenders, and your Committee have also included in the appendix other communications which have been addressed to your Honourable Board on the question of the sewage.

All which your Committee beg to submit.

(Signed)

J. Thwaites.
William Tite.
J. Pew.
W. H. Dalton.
Charles Harris.
P. H. Le Breton.
George Peckett.
Philip Crellin.
G. B. Richardson.
Silas Taylor.
F. Healey.
Robert Freeman.
Edward Shepherd.
E. C. Dermer.
William Carpmael.
J. S. Phillips.
J. O. Hall.
Wm. H. Lammin.
Fred. Doulton.

RESOLUTIONS in reference to the Utilisation of the Metropolitan Sewege, passed by Vestries, District Boards, City Wards, and Public Meetings.

Board of Works for the Westminster District.

Offices, Great Smith-street,
Westminster S.W.
16 March 1863.

Dear Sir,

I am instructed by the Board of Works for this district to forward you a copy of a resolution herewith enclosed, with reference to the disposal of the London sewage, and I am to request that you will submit such resolution to the Metropolitan Board at the earliest opportunity.

I am, &c.
(signed) *W. F. Jebb,*
Clerk.

J. Pollard, Esq., Clerk,
Metropolitan Board of Works.

At a Meeting of the Board of Works for the Westminster District, held on Friday, 13 March 1853,

It was resolved,

That this Board views with alarm a proposal now before the Metropolitan Board of Works to take the sewage of the northern area, and apply it to a limited tract of barren land on the coast of Essex.

The Board, considering that such a project could never be of any value to the ratepayers of the metropolis, respectfully urge on the Metropolitan Board the propriety of preferring some measure for dealing with the sewage which contemplates a general application of the same for agricultural purposes, as distinguished from its application to a limited tract of land.

Extracted from minutes.

(signed) *W. F. Jebb,*
Clerk.

To the Metropolitan Board of Works.

The Memorial of the St. Saviour's District Board of Works.

Showeth,

That your memorialists are deeply impressed with the vast and important benefits which may be secured to the various parishes or districts within the area of the jurisdiction of the Metropolis Local Management Act, by the utilisation of the sewage for general agricultural purposes.

That your memorialists, under a strong desire to aid your Honourable Board as far as they can in a matter of such deep interest, take leave to urge upon your Honourable Board the fullest consideration of this important subject, and the desirability of such measures being taken as may appear to your Honourable Board the most expedient for the disposal and conversion of such sewage for agricultural and other purposes, on the most advantageous terms.

(L. S.)

Parish of Bermondsey, Surrey,
Vestry Office, Maltby-street, S.E.
Gentlemen, 18 March 1863.

I AM directed to inform you that on Monday last, the vestry of this parish having had under their consideration the subject of the utilisation of the sewage of the metropolis, they came to the following resolution, viz.:

"That in the opinion of this vestry no concession of the sewage of the metropolis should be made for a lengthened period, without a considerable sum being derived annually therefrom towards reimbursing the ratepayers of the metropolis the great expense they have incurred in constructing works for the collection of the same," and earnestly to request, that as the ultimate value of the sewage will, doubtless, be immense, your Honourable Board will not be hurried into a hasty concession of it, but that you will be pleased to use every effort in disposing thereof to lighten the burdens of the ratepayers.

(L. S.)

I am, &c.
(signed) *J. I. Riches*,
Assistant Clerk.

The Metropolitan Board of Works,
Spring-gardens.

THE Board of Works for the Wandsworth District.

Battersea-rise, Wandsworth, S.W.,
Dear Sir, 26 March 1863.

ON the other side I send you copy resolutions agreed to by this Board yesterday, which I shall feel obliged by your presenting to the Metropolitan Board of Works at their meeting to-morrow.

Yours, &c.
(signed) *Arthur Alex. Corsellis.*

William Carpmael, Esq.

That this Board recognising the facts that the sewage of the metropolis is the property of the ratepayers, and is of enormous value as a source of agricultural manure, desire to press upon the Metropolitan Board of Works the importance of the mode in which it is dealt with.

That the evidence taken before the Select Committee of the House of Commons upon Town Sewage, having established that the greatest results follow from its moderate application over an extended area of land, the Metropolitan Board of Works should, in the opinion of this Board, contemplate and provide for its future utilisation in that manner, or both the return to the ratepayers, and the advantage to agriculture would, according to that evidence, be jeopardised or lost.

That Mr. Carpmael be requested to present a copy of these resolutions to the Metropolitan Board of Works.

(Extracted from the Minutes.)

(signed) *Arthur Alex. Corsellis*,
Clerk.

To the Metropolitan Board of Works.

The MEMORIAL of the Vestry of the Parish of Rotherhithe, in the County of Surrey, under their Common Seal,

Showeth,

THAT the Vestry of this Parish, recognising the facts that the sewage of the metropolis is the property of the ratepayers, and is also of enormous value as a source of agricultural manure, desire to press upon the Metropolitan Board of Works the importance of the mode in which it is dealt with.

That the evidence taken before the Select Committee of the House of Commons upon town sewage, having established that the greatest results follow from its moderate application over an extended area of land, this Vestry submit that the Metropolitan Board of Works should take the subject into their consideration with the view of providing for the future utilisation of the sewage in that manner; as, otherwise, the benefit derivable therefrom to the ratepayers, as well as the advantage to agriculture, would, according to that evidence, be jeopardised or lost.

(L. S.)

The Vestry of the Parish of Lambeth.

Vestry Hall, Kennington-green, S.
28 April 1863.

UTILISATION of SEWAGE.

Dear Sir,

As instructed by Vestry, I beg to forward you copy of Resolution passed at a Vestry meeting held on the 23d instant, in relation to the utilisation of sewage.

Resolved, that a communication be made to the Metropolitan Board of Works, urging them to withdraw or modify their advertisements for tenders, so as to secure a fair and open field to all competitors.

I remain, &c.
(signed) *Thomas Roffey*,
Clerk to the Vestry.

John Pollard, Esq.

To the Metropolitan Board of Works.

The MEMORIAL of the Board of Works for St. Olave District, Southwark:

Showeth,

THAT the sewage of the metropolis is the property of the ratepayers, and should be dealt with so as to secure for them the greatest amount of relief from local burthens.

That, from the investigation of eminent chemists, the evidence taken before the Select Committee of the House of Commons on the sewage of towns, (1862), has proved that it contains an enormous amount of manure, equal in quality to the best Peruvian Guano.

That the evidence taken before the same Committee, and the agricultural experiments there detailed, incontestibly prove, in the opinion of this Board, that the greatest results follow from the application of the sewage, in moderate quantities, over an area of great extent.

That it would be within the province of a public Company to become the carriers and distributors of

App. No. 14. of sewage, by engineering means, to the agriculturists by whom it would be employed.

That your Honourable Board in 1860 advertised for tenders for dealing with sewage, and that you are now again advertising for the same purpose.

That the example set by the metropolis is certain to have a great effect on the proceeding of the other cities and towns of England, leading, if it is in the right direction, to an incalculable increase of the products of the soil.

Your memorialists therefore humbly trust that your Honourable Board will be pleased to take such measures, in dealing with the sewage of the metropolis, as will enable your Board to receive a revenue from the sale of it, and thus relieve the ratepayers from some of the expense which they are called upon to bear.

Sealed by order of the Saint Olave's District Board of Works.

(signed) *Robert Slee,* Clerk. (L. S.)

5 May 1863.

The Vestry of the Parish of St. Mary, Lambeth.
UTILISATION of Metropolitan Sewage.

Vestry-hall, Kennington-green,
9 July 1863.

Dear Sir,

ACTING, upon the direction contained in the sixth resolution, set forth on the other side, I beg to forward this communication, with a request that you will be pleased to submit the same to the Metropolitan Board of Works, at your earliest convenience.

I am, &c.
(signed) *Thomas Roffey,*
Clerk to the Vestry.

Robert Taylor, Esq.

UTILISATION of Metropolitan Sewage.

AT general meetings of delegates, held at the Vestry-hall, Kennington, on the 17th day of June, and the 8th day of July 1863, the following Resolutions were passed:

F. H. Fowler, Esq., in the Chair.

It was moved by Mr. J. G. Rhodes, seconded by Dr. Strete, and

Resolved unanimously: That in the opinion of this meeting, the concurrent testimony of scientific men, and the results obtained by practical men, are decisive as to the value of sewage as a means of fertilisation.

It was moved by Mr. George Newman, seconded by Mr. J. W. Hopkins, and

Resolved unanimously: That in the opinion of this meeting, the sewage of the metropolis is the property of the ratepayers, and should be dealt with for their advantage, with a view of reducing local taxation.

It was moved by Mr. A. N. Shaw, seconded by Mr. J. G. Rhodes, and

Resolved unanimously: That the Metropolitan Board of Works having signified their intention of opening tenders for the utilisation of the sewage, on Friday next, the delegates are of opinion that the fullest publicity should be given by the Metropolitan Board of Works to all tenders and proposals for dealing with the same before any tender is accepted; for, as an almost unanimous opinion is now held as to the value of sewage as a fertiliser, yet the plan for its profitable and easy utilisation is open to much preliminary discussion and experiment.

It was moved by Dr. Barren, seconded by Mr. Rhodes, and

Resolved unanimously: That Mr. Ayrton, M.P., be requested to move in Parliament for copies of all advertisements published by the Metropolitan Board of Works since its formation, calling for tenders for dealing with the sewage, as well as for copies of all reports, or other information, in any way affecting or relating to the applications which have been made to the Board for the sewage. And all reports by the officials of the Board, or the Main Drainage Committee upon the said plans or proposals; and, for the convenience of reference, that all letters, reports, or other information affecting each case, shall be kept distinct and separate in the return. And that the Metropolitan Board of Works, at the same time, do furnish copies of all evidence taken by them at any time, or any information furnished to them by any person, as to the agricultural value of town sewage.

Resolved: That copies of these resolutions be sent to all the Metropolitan Members of Parliament, and that they be respectfully requested to support Mr. Ayrton's motion calling for the said returns.

Resolved: That copies of the previous Resolutions be sent to each Vestry and District Board within the metropolitan area, and to the Corporation of London, also be entrusted to Mr. Robert Taylor, to be laid by him before the Metropolitan Board.

(signed) *F. H. Fowler,* Chairman.

Sir,

I HAVE unfeigned pleasure in transmitting to you, by the request of the "City of London Tradesmen's Club," the enclosed copy of the Resolution, unanimously adopted by the meeting, 22d instant.

I have, &c.
(signed) *George Whipple,* F.C.S.,
Honorary Secretary.

26 October 1863,
Salter's Hostel, Farringdon-road.
To the Chairman,
Metropolitan Board of Works.

City of London Tradesmen's Club,
Thomas Sangster, Esq., M.R.C.V.S.,
Chairman.

IT was resolved that a copy of the following Resolution be forwarded to the "Metropolitan Board of Works":

"That it is one of the first duties of the Board of Works to utilise the sewerage for the benefit of the country."

(signed) *George Whipple,* F.C.S.,
Honorary Secretary.

22 October 1863.
Salter's Hostel, Farringdon-road.

Parish of St. John, at Hackney.

Town Hall, Hackney,
Sir, 14 November 1863.

I AM directed to forward, for the information of your Board, a copy of the Resolution of the Vestry of the parish of St. John at Hackney, upon the question of the utilisation of the sewage of the metropolis :—

"That this Vestry, having considered the plans for the utilisation of the metropolitan sewage, are of opinion that the interests of the ratepayers will be best secured by the concession of the metropolitan sewage to Mr. Thomas Ellis, who, by proposing to divide the profits with the ratepayers, makes an offer which appears likely to effect a large reduction in the local taxes, without any risk of loss to the ratepayers.

"That a copy of this Resolution be communicated to the Metropolitan Board of Works, the Metropolitan Vestries, also that a copy be furnished to the Corporation of London, to be presented by a deputation of the Vestry, and that the Corporation be respectfully requested to aid the ratepayers in procuring the economic and profitable utilisation of the metropolitan sewage, with a view to the reduction of local taxation."

I have, &c.
(signed) *Richard Ellis*,
Clerk of the Vestry.

J. Pollard, Esq.

Bishopsgate Ward,
Ratepayers' Association,
Committee Room,
30, Bishopsgate-street Without,
Sir, December 1863.

I AM instructed by the Bishopsgate Ward Ratepayers' Association to forward to you a copy of Resolutions, with reference to the economic and profitable utilisation of the metropolitan sewage, which were unanimously passed at a meeting of the Association on the 9th instant, and have to ask of you the favour of bringing them under the consideration of your Board at its next meeting.

I am, &c.
W. W. Stuart,
Secretary.

To John Pollard, Esq.,
Clerk to the
Metropolitan Board of Works.

First Resolution: "That this meeting, in view of the evidence laid before the Select Committee of the House of Commons on Sewage of Towns, and of the analysis of the metropolitan sewage made by Messrs. Hoffman and Witt, is of opinion that the metropolitan sewage is a manure valuable for all crops, and that it can be profitably utilised. That its profitable utilisation depends upon its application in a liquid form, in moderate dressings, over an area of not less than 500,000 acres, and that any other mode will be financially unprofitable. And further, that as Mr. Thomas Ellis, as appears from the information now published with the tenders for the sewage by the Metropolitan Board of Works, did in the early part of 1861 submit to that Board the full details of a plan in accordance with the foregoing principles and conditions, before the appointment by Parliament of the Select Committee on Sewage of Towns, and at a time when the value of sewage, or the proper area for its profitable absorption, in addition to the manure made on the area, was unknown, Mr. Ellis is, in the opinion of this meeting, entitled to the credit of having solved for the country the problem of the economic and profitable utilisation of town sewage."

Second Resolution: "That in the opinion of this meeting, the agricultural value of sewage as a manure is only to be correctly ascertained from the results obtained by those who have used it for years, not for the purpose of proving anything, but simply to obtain, by its assistance, the largest and most profitable return in their crops. This meeting, therefore, disapproves of all experiments (no matter by whom conducted) initiated for the purpose of proving or disproving its value, and is of opinion that the great national question of the economic and profitable utilisation of the metropolitan sewage can only be satisfactorily tested before a Committee of the House of Commons; and as Mr. Bazalgette, and a large number of the Metropolitan Board of Works did, in the year 1861, commit themselves to a plan for getting rid of the sewage as a nuisance, by supporting the scheme of Mr. Napier, for putting the sewage of the north side on 20,000 acres, from which no return could be made to the ratepayers, and which scheme is still before the Board for consideration; and as the Chairman of the Metropolitan Board of Works, so recently as last July, publicly asserted, on more than one occasion, that the sewage was so 'extremely diluted,' that it would not pay, commercially, to distribute it by steam power if it had to be lifted 22 feet, which, as is well known, would only cost the one-hundredth part of a penny per ton, this meeting has heard with alarm that the Metropolitan Board of Works, instead of referring the question of the utilisation of the sewage to Parliament, has sent it for consideration to the Main Drainage Committee, where it will be considered by persons already committed to Mr. Napier's system of enormous dressings over small areas; and, further, that the Committee, as is usual with it, will sit in private, the press and public being excluded."

Resolved: "That this meeting most strongly disapproves of such a method of treating this great national question; and, as Mr. Ellis has for years consistently advocated the economic and profitable utilization of town sewage, this meeting is of opinion that the interests of the ratepayers and of the nation will be best promoted by the Metropolitan Board of Works at once entering into such arrangement with Mr. Ellis as will admit of his taking this great question before Parliament."

Third Resolution: "That the sewage of the metropolis (as first proclaimed by Mr. Ellis) is the property of the ratepayers, and must be dealt with so as to produce for them the greatest amount of benefit; this meeting therefore deprecates in the strongest manner any attempt on the part of the Metropolitan Board of Works to demand a fixed rent for the same, as such must necessarily prove most detrimental to the interests of the ratepayers for the following reasons: Because the value of the sewage is a matter still in dispute; and because its annual volume is so vast, that were its actual value determined beyond all doubt, no company could raise the capital necessary for its proper utilisation were they called on to guarantee a fixed rent equal to the sum that the ratepayers have a right to expect, and which they can

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can easily obtain under a more equitable arrangement; and because it would therefore be a manifest injustice to the ratepayers were the Metropolitan Board of Works, by making a demand that could not be complied with, to prevent the profitable utilisation of the sewage; and because it would be unjust to the ratepayers for the Metropolitan Board of Works to aggrandise a Company at the expense of the ratepayers, by granting a concession of the sewage for a small rent on the plea that it was guaranteed; this meeting therefore most strongly disapproves of any such demand being made, and is of opinion that the only arrangement that can be made, which would at the same time be just to the ratepayers, and yet not prevent a Company raising a capital for the utilisation of the sewage; and as Mr. Ellis has offered to undertake all the expense and risk of utilising the sewage, and to deposit in the bank the sum of 60,000 *l.* for the preliminary expenses, and has also undertaken to protect the ratepayers and the Metropolitan Board of Works, by a special Act of Parliament, from all risk or liability of every sort, and to divide equally with the ratepayers every shilling made by his Company, which is the highest offer that has been made to the Metropolitan Board of Works for the sewage; this meeting is of opinion that the interests of the ratepayers require Mr. Ellis's offer should be accepted, and that he has fully entitled himself to the confidence and support of the citizens of London.

"That copies of these Resolutions be sent to the Metropolitan Board of Works, and to the Vestries and District Boards, as well as to all the City Wards; and that they be sent to the town clerk from this meeting for presentation to the Corporation of London."

(signed) *John Richardson,*
Chairman.

By Order,
John Pollard,
Clerk of the Board.

Spring Gardens, 6th May 1864.

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LETTER from Viscount *Torrington* and others, on the DISPOSAL of the SEWAGE of the METROPOLIS.

DISPOSAL OF THE SEWAGE OF THE METROPOLIS.

8, New Street, Spring Gardens, S. W.,
1 August 1863.

Gentlemen,

REFERRING to the letter of the 6th ultimo on this subject, addressed to you, and signed by Viscount Torrington, Sir Charles Fox, and Mr. Thornton Hunt, we beg to say that, should time be granted for making the necessary deposits for Parliament, we will undertake to submit the details of our projected plan for your consideration, on or before 26th October 1863.

We are, &c.
(signed) *Torrington,*
Charles Fox,
Thornton Hunt.

To the Commissioners of the Metropolitan
Board of Works, Spring Gardens, S. W.

Appendix, No. 16.

Utilization of Metropolitan Sewage.

App. No. 16.

COPIES of all Resolutions in reference to the Utilization of the Metropolitan Sewage passed by the Metropolitan Vestries, District Boards, City Wards, City Corporation, or Public Meetings, of which Copies have been forwarded to the Metropolitan Board of Works.

Resolutions agreed to at a public meeting of the ratepayers and inhabitants of Hackney, held in the Town Hall, Church-street, Hackney, on Wednesday, 23 September 1863.—Extracted from the "Star," of 24th September:—

"That this meeting, in view of the Evidence laid before the Select Committee of the House of Commons on Sewage of Towns, and of the Analysis of the Metropolitan Sewage made by Dr. Hofmann and Mr. Witt, is of opinion that the metropolitan sewage is a valuable manure for all crops, and can be profitably utilized; that its profitable utilization depends upon its application in a liquid state in moderate dressings over large areas, and that any other mode will be financially unproductive."

"That a plan, based upon the principles and conditions stated in the previous resolution, is the only one that can accord with the inferences from the Evidence given before the Select Committee on Sewage of Towns, that the adoption of such a plan is calculated to produce a great reduction in local taxation, and that the opposition thereto of importers and manufacturers of artificial manure is inimical to the public interests, and deserving of reprobation."

"That the resolutions agreed to this evening be forwarded to the Metropolitan Board of Works, to the Metropolitan Vestries, to the members of the Corporation of London, and to the Metropolitan Members, and their co-operation solicited."

Resolutions agreed to at a public meeting of the ratepayers and inhabitants of Marylebone, held at the Vestry Hall, on Thursday, 15 October 1863.—Extracted from the "Star" of 16th October:—

"That this meeting, in view of the Evidence laid before the Select Committee of the House of Commons on Sewage of Towns, and of the Analysis of the Metropolitan Sewage made by Messrs. Hofmann and Witt, is of opinion that the metropolitan sewage is a manure valuable for all crops, and that it can be profitably utilized. That its profitable utilization depends upon its application in a liquid form, in moderate dressings over a large area, and that any other mode will be financially unproductive; and further, that therefore a plan based upon the foregoing principles and conditions is the only one which offers any passport of a substantial reduction of local taxation."

"That, in the opinion of this meeting, the agricultural value of sewage, as a manure, is only to be correctly ascertained from the results obtained by those who have used it for years; not for the purpose of proving anything, but simply to obtain, by its assistance, the largest and most profitable returns in their crops. This meeting, therefore, disapproves of all experiments (no matter by whom conducted) initiated merely for the purpose of proving or disproving its value."

Resolutions agreed to at a public meeting of ratepayers and inhabitants of Lambeth, passed on the 16th of October 1863.—Extracted from the "Star."

"That this meeting, in view of the evidence laid before the Select Committee of the House of Commons on Sewage of Towns, and of the Analysis of the Metropolitan Sewage, made by Messrs. Hofmann and Witt, is of opinion that the metropolitan sewage is a manure valuable for all crops, and that it can be profitably utilized. That its profitable utilization depends upon its application, in a liquid form, in moderate dressings, over a large area, and that any other mode will be financially unproductive. And further that, therefore, a plan based on the foregoing principles and conditions is the only one which offers any prospect of a substantial reduction of local taxation."

"That, in the opinion of this meeting, the agricultural value of sewage, as a manure, is only to be correctly ascertained from the results obtained by those who have used it for years; not for the purpose of proving anything, but simply to obtain, by its assistance, the largest and most profitable return in their crops. This meeting, therefore, disapproves of all experiments (no matter by whom conducted) initiated merely for the purpose of proving or disproving its value."

App. No. 16.

REPORT of Sewers Committee of St. Mary's, Islington, to the Vestry, upon the tenders for the Metropolitan Sewage.—Dated 29th February 1864.

On the communications from St. James', Westminster, St. John, Hackney, and the Bishopsgate Ward Ratepayers' Association, your Committee concur generally in the opinions expressed therein, especially in reference to the plan and tender of Mr. Thomas Ellis.

Of all those sent in, his scheme appears to be the most practicable, and his tender the most advantageous to the ratepayers of the metropolis; but your Committee are strongly of opinion that, in a matter of so much importance, and upon which there is such a diversity of ideas, undue haste should be avoided; and that no concession of the sewage should be granted by the Metropolitan Board until after there has been a further investigation of the fullest and fairest kind.

BISHOPSGATE WARD.

At a ward meeting held at the school-room, Bishopsgate Churchyard, within the said ward, on Tuesday, the 19th day of January 1864, to consider the best means of procuring the economic and profitable utilization of the metropolitan sewage, with a view to a reduction of local taxation, and to take such measures as may be deemed advisable thereon,—

Mr. Deputy *Jones* in the Chair,

It was moved by Mr. Richardson, seconded by Mr. Stapleton, and resolved unanimously,

"That this meeting in view of the evidence taken by the Select Committee of the House of Commons on Sewage of Towns, is of opinion that the metropolitan sewage is a manure suitable to all crops, and that its profitable utilization depends upon its application in a liquid form in moderate dressings, over an area of not less than 500,000 acres. But as the artificial manure trade, its friends and partisans in their efforts to prevent town sewage being generally utilized upon the economic principle, and thus brought into general competition with artificial manure, assert that the metropolitan sewage is so diluted as to be all but worthless as a fertiliser, this meeting is of opinion that it would be for the interest of the heavily taxed ratepayers of the metropolis, that the value of the sewage which is their property, should be definitely settled by a Parliamentary inquiry, with a view to its immediate and profitable utilization, and that the great interest at stake demands that the conduct of that inquiry should be entrusted to a gentleman in whose knowledge of the subject, and in whose devotion to them, the ratepayers can confide."

It was moved by Mr. Morris, seconded by Mr. Richards, and resolved unanimously,

"That this meeting having learnt from the tenders for the Metropolitan Sewage, which have been published by order of the Metropolitan Board of Works, that Mr. Thomas Ellis did, in the year 1861, lay before that Board the full details of a plan for the economic and profitable utilization of the sewage over an area of not less than 500,000 acres; and this meeting also finding that Mr. Ellis has offered to execute all the works necessary for the profitable utilization of the sewage, and to carry on the distribution of the sewage free of all charge to the ratepayers, as well as to undertake, at his own cost, the entire expense of a Parliamentary Inquiry as to the value of the sewage, and is prepared to lodge 60,000 *l.* in the Bank for preliminary expenses; and, further, that he has offered to protect the Metropolitan Board of Works, and the ratepayers, by a Special Act of Parliament from all liability, whilst giving that Board the fullest control over the working of his Company, and to pay an annual rent to be applied to the reduction of local taxation equal to one-half the profits derived from the sale of the sewage, such rent in all probability not being less than 1,000,000 sterling per annum; and that he has further agreed not to raise any capital from the public for the purposes of his Company until he has first fully proved before Parliament the great agricultural and commercial value of the Metropolitan Sewage,—Resolve that Mr. Ellis's offer is most just and equitable, and that the interests of the ratepayers demand that this tender should be accepted; and that Mr. Ellis has proved by his consistent advocacy for years of the rights and interests of the ratepayers, and by his numerous works on the economic and profitable utilization of the Metropolitan Sewage, that there is no other person in whose hands the interests of the ratepayers would be safer, or who is so well qualified to be entrusted with the conduct of the inquiry before Parliament as to the agricultural and commercial value of the Metropolitan Sewage."

It was moved by Mr. Baxter Langley, seconded by Mr. Richardson, and resolved unanimously—

"That the best thanks of this meeting be given to Mr. Deputy Jones for the efficient manner in which he had presided."

And it was also resolved—

"That the above Resolutions be sent to each member of the Corporation, to each Ward of the City, to the Metropolitan Vestries and district Boards of Works, to the Metropolitan Board of Works, and to the town clerk for presentation to the Corporation of London."

Joesph Harris, Ward Clerk.

PORTSOKEN WARD.

2, America Square,
17 March 1864.

Sir,

I BEG to hand you a copy of certain resolutions passed at a meeting of the inhabitants of this ward in favour of a plan for utilizing the sewage of the metropolis. And I am instructed on behalf of the inhabitants to request your support of a measure which if carried into effect will, it is submitted, greatly benefit the ratepayers of the metropolis.

I have, &c.
(signed) *W. M. Batho,*
Ward Clerk.

Portsoken Ward, in the City of London.

At a Meeting of the Inhabitants of this Ward, held before Sir Francis Graham Moon, Bart., Alderman of the Ward, on Wednesday, the 16th day of March 1864,

It was unanimously Resolved:

1. "THAT this meeting, in view of the local taxation of the metropolis, which presses so heavily upon all, but especially upon the poorer classes, is of opinion that the sewage of the metropolis, which is the property of ratepayers, should, without further unnecessary delay, be so utilised as to procure for them the greatest relief from local taxation, and for the people the largest increase to their supplies of food. And having regard to the results obtained in different parts of the country, with sewage as diluted, if not more diluted than that of London, is of opinion that the metropolitan sewage is a manure suitable for all description of crops; and if applied in a proper manner by the hose and jet in moderate quantities, certain to yield such returns in crops as to enable those using it in that manner to pay such a price for it as would afford a suitable relief to the ratepayers in the reduction of their local taxation, and a great increase in our supplies of food for the people. But this meeting is of opinion that the utilisation of the sewage should not be undertaken at the cost of the ratepayers; believing that it would be most objectionable that the Metropolitan Board of Works, or any other Board, should have the power to tax the ratepayers, and enable that, or any other Board, to enter into a gigantic mercantile speculation; but that the works should be undertaken at the cost and risk of a Company who should pay to the ratepayers an annual rent for the use of the sewage. This meeting, therefore, resolves, that it is the imperative duty of the Metropolitan Board of Works, as the trustees of the ratepayers in this matter, to facilitate in every way the economic and profitable utilisation of the sewage, through the instrumentality of a Company."

2. "That this meeting has learned that the available sewage of the metropolis amounts to about 266,052,440 tons per annum, and that the fertilising matter contained therein, if extracted and dried, would be worth 2,837,353 *l.* per annum, taking Peruvian Guano, sold at 13 *l.* 10 *s.* per ton, as the standard of value. But, as shown by the evidence taken by the Select Committee of the House of Commons on Sewage of Towns, the effect of any manure on crops is greatly increased by being liquified, as is the fertilising matters contained in the sewage, it follows that the metropolitan sewage must be worth a larger sum than would be indicated by the value of the manure it contains, if extracted and dried. Having regard to these facts, as well as that the agricultural and commercial value of the sewage is not yet generally understood, and has for years been systematically denied by the importers and manufacturers of artificial manure and their partisans, this meeting is of opinion that the capital necessary for the economic and profitable utilisation of the metropolitan sewage could not possibly be raised were the Metropolitan Board of Works to demand a fixed rent for the same, unless the amount was, comparatively speaking, of so small an amount that it would be a gross injustice to the ratepayers; and that, therefore, the only plan that can be adopted in the utilisation of so vast and valuable a property, that would not throw any obstacle in the way of raising the capital for the works, and yet secure for the ratepayers a fair amount of profit, would be a fluctuating rent equal to a certain proportion of the profits derived from the sale of the sewage by the company undertaking its distribution to the farmers. This meeting, therefore, resolves that it would be a self-evident injustice to the ratepayers, was any impediment thrown in the way of the profitable utilisation of their property by the Metropolitan Board of Works demanding a fixed rent for the same."

3. "That this meeting having heard Mr. Ellis's plan for the utilisation of the sewage, now before the Metropolitan Board of Works, find that the plan of distributing the sewage by gravitation from a summit-regulating reservoir on either side of the Thames, through pipes laid along the roads of an area of 1,680 square miles, which area can be enlarged as required by merely extending the pipes further along the roads, is feasible."

"This meeting further finds that Mr. Ellis purposes to lay down all the works of distribution at the expense of the Company, and to undertake all outlays and risks of every kind, guaranteeing the Metropolitan Board of Works and the ratepayers, by a special Act of Parliament, from all liability, including that of partnership; and that he is prepared to deposit 60,000 *l.* for preliminary expenses, and to undertake not to raise any of his capital from the public until he has first submitted his plans to a rigid Parliamentary inquiry, thus protecting the ratepayers from all fear of the adoption of a crude or impracticable, or unprofitable scheme, and the public from investing their money on a doubtful speculation; and that Mr. Ellis has further undertaken, after obtaining his Act of Parliament, not to advertise his Company until the Metropolitan Board of Works shall have first approved of his Board of Directors, and that half a million sterling of the capital of his Company shall have been subscribed for by his private supporters. And that Mr. Ellis, on behalf of his Company, undertakes to pay an annual rent for the sewage equal to one-half of the net profits derived from its sale; which half, assuming that the sewage was sold only at the value of the manure it contains, if extracted and dried, would produce a revenue for the ratepayers exceeding 1,000,000 sterling per annum, equal to one-third of the entire local taxation of the Metropolis. This meeting further finds that Mr. Ellis's tender is the highest that has been made, and is of opinion that it is most just and equitable, and calculated to secure public confidence, and such perfect harmony of interest between the ratepayers of the Metropolis and the shareholders of his Company, as will be certain greatly to promote the best interest of both. This meeting, therefore, resolves that Mr. Ellis's proposition is entitled to the support of the ratepayers of the Metropolis."

"That a copy of these resolutions be forwarded from this meeting to the Chairman of the Metropolitan Board of Works and to the Town Clerk for presentation to the Corporation of London. And that copies, with a letter from the Ward Clerk, requesting co-operation in this most important matter, be sent to each Member of the House of Commons, to each Member of the Corporation of London, and to each Member of the Metropolitan Board of Works, as well as to each of the Metropolitan Vestries and District Boards of Works, and to the City Wards."

W. M. Batho, Ward Clerk.

App. No. 16.

ALDGATE WARD.

Copy of a Resolution passed at a Meeting of the Members of Aldgate Ward Ratepayers' Association, 30th May 1864.

Proposed by Mr. E. Dresser Rogers; seconded by Mr. R. B. Whiteside, C.C.; and carried unanimously,

"That this meeting is of opinion that evidence having been given by practical agriculturists, chemists, and engineers, that the sewage of towns, when properly applied, is of great value as a manure, and the result of its being used at several parts of England and Scotland, showing that there should not be any engineering difficulties in such application, this meeting considers it of the utmost importance that, in the consideration of the question, one of the principal points is to obtain the earliest possible assistance in the reduction of local taxation, and that the schemes now before the Board of Works should receive the earliest possible consideration; and that, looking at the fact that the sewage of the Metropolis is of a value estimated beyond 2,000,000 *l.* per annum, it is imperative that the ratepayers should be interested to an extent of at least one-half any profit to be derived from its sale, and that the adoption of any plan by which a comparatively small annual fixed rental would be paid for the sewage is not deserving the approval of the ratepayers of the Metropolis."

Henry Thomas Parkin,
Chairman.

WARD OF FARRINGDON WITHOUT.

AT a Meeting of the Inhabitants of this Ward, held at the Sessions House, Old Bailey, in the City of London, on Tuesday, the 19th day of April, 1864, to take into consideration the best means to be adopted to secure the economic and profitable utilization of the Sewage, with the view to the reduction of our local taxation,

Alderman Sir James Duke, Bart., M.P., in the Chair,

It was *Resolved,*—"That this Meeting, being deeply impressed with the enormous value of the sewage of the metropolis, regrets that no scheme has yet been adopted for utilizing the same, and is apprehensive that from the forward state of the Main Drainage Works the opportunity of doing so will be imperilled, if not lost. That whilst this Meeting feels that it is not desirable for the Metropolitan Board of Works to levy a compulsory rate for a commercial speculation, yet it is their manifest duty to facilitate measures of private enterprise, for the economical and profitable utilization of the sewage."

Resolved,—"That this Meeting having considered the three several tenders to the Metropolitan Board of Works, viz.: Napier & Hope, Lord Torrington and others, and Mr. Thomas Ellis, is of opinion that Mr. Ellis's plan is greatly superior to either of the others, for the following reasons: That Mr. Ellis affords a definite guarantee for the practical execution of his works by depositing 60,000 *l.* for preliminary expenses of establishing his Company; and has undertaken not to raise any of his capital until after he has submitted his theory of economic sewage utilization, and his plan of distribution over the large area of 500,000 acres to the investigation of Parliament; and that he will not proceed to form his Company until the Metropolitan Board of Works shall have approved of his directors, and half a million sterling of the capital of his Company shall have been subscribed for by his private supporters; and that, as Mr. Ellis's tender for the metropolitan sewage, without entailing any liability upon the ratepayers, offers to them greater advantages than any other tender that has yet been made, it deserves the support of the ratepayers of this metropolis, of our other cities and towns, the landed interests, and the Government."

Resolved,—"That a deputation from this ward meeting do wait on the Chancellor of the Exchequer, to present to him the foregoing Resolutions, and urge that the Government will give its support to the motion of Lord Robert Montagu, for the appointment of a Select Committee on the Sewage of Towns, and that the Committee be specially instructed to inquire and report on the plans and tenders now before the public, or which may be proposed, for dealing with the metropolitan sewage: That a petition, embodying the views contained in the foregoing Resolutions, be presented to both Houses of Parliament: That Earl Derby be respectfully requested to present the same to the House of Lords, and Sir James Duke, Bart., to the House of Commons; also, a petition to the Common Council of the City of London, requesting their co-operation; and also that a detailed report of this ward meeting, as expressed this day, be circulated round the ward, a copy sent to each Member of Parliament, the Court of Common Council, the Metropolitan Board of Works, and to each metropolitan vestry, asking their consideration and support to the same."

John Pontifex,
Ward Clerk.

5, St. Andrew's-court,
Holborn.

Appendix, No. 17.

Metropolitan Board of Works.

COPY of Letters relative to the Utilization of the Sewage of the Metropolis.

App. No. 17.

6, Wilby Road, Grove Lane,
Camberwell,
Sir, 18 September 1863.

Having arranged a system for the utilization of sewage, by which manure, manufactured from it, might be disposed of to a very large extent, both in England and abroad; and a rent, at a definite rate per ton, realised by the Board, I should be obliged if you would favour me with information respecting the following particulars:—

1st. Whether the Board would be willing to take into consideration a tender for a portion only, and that comparatively small, of the London sewage?

There is every reason to anticipate that the eventual demand for the manure manufactured, would be very large; but it would be desirable, if not essential, that the promoters should first obtain a concession of a small quantity, such, perhaps, as 1,000,000 tons, to enable them to test the principle of their system on the scale of actual business; and to prove, practically, the nature of the demand for their manure, before raising the large capital that it would require to take a lease of a large portion of the sewage, and to carry out the extensive works and mercantile arrangements that such a lease would render necessary.

2d. In the event of the Board being disposed to take into consideration such a preliminary tender, when could it be submitted to them, and what forms should be used?

3d. As the process would (at any rate until further perfected) leave waste water, not altogether free from impurity, would the Board allow of such waste water being discharged into the Thames?

4th. If they would not do so permanently, would they allow of its being so discharged during the period of the preliminary contract, or for a limited time, sufficient to allow of the system being tested, and, if necessary, improved and perfected?

5th. Should any arrangement be made, at what time might the Board be expected to commence delivering the sewage?

It is believed that the promoters would be able, in the event of a favourable answer being returned to this letter, to offer to the Board a higher definite rental, for such portion of the sewage as they might lease, than there seems to be any probability of their obtaining through any of the systems which have, as yet, been proposed.

I am, &c.
(signed) *Jas. Edw. Nelson*
The Secretary of the
Metropolitan Board of Works.

To the Honourable the Metropolitan
Board of Works.

London,
Gentlemen, 24 September 1863.

Believing that the evidence given before the Select Committee of the House of Commons on Sewage of Towns, by many agriculturists who have used sewage to land in various parts of the kingdom, clearly proves that, if properly used (that is, in moderate quantities by hose and jet under pressure), it may be made the source of very considerable revenue to the towns producing it; but also believing that, owing to the unsatisfactory results of the Rugby experiments as compared with that evidence, and the unprecedented nature of the undertaking, it will be impossible to raise the large capital requisite for the profitable utilization of the sewage of London until confidence, as to the remunerative character of the investment, has been established in the minds of capitalists and the public, by some well organised and conclusive trial with it, in a manner that will afford an unquestionable test of its value, we, the undersigned, beg to submit, for the consideration of your Honourable Board, certain terms on which we are prepared immediately to provide the capital necessary for taking, stock, and working, with the London sewage, a farm in a suitable locality.

The terms we propose are,—

First. That your Honourable Board shall provide at the farm, a supply of 350 to 400 tons of sewage per acre per annum, for the whole acreage.

Secondly. That a concession of the whole of the London sewage shall be guaranteed to us, on condition that we are prepared, within some period to be agreed on, with the capital and plans necessary for obtaining from Parliament such powers as may be required for its utilization.

Thirdly. That the whole of the net profits arising from such utilization, after providing for a reasonable sinking fund, and a preference dividend of 5 per cent. on the capital employed, shall be equally divided between your Honourable Board and the Company.

Fourthly. That, inasmuch as upon these term the interests of the ratepayers and of the Company will be identical, the concession shall contain such conditions as your Honourable Board may consider necessary for duly protecting the interests of its constituents and the public health.

Provisional arrangements have been made for the immediate occupation of a suitable farm adjoining the Northern High Level Sewer, at a point where the sewage can now be at once supplied at a very trifling outlay, as well as for securing the services of a manager who has had great experience in the agricultural use of sewage, and who gave very important evidence

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dence before the Select Committee; and we confidently believe that, should your Honourable Board see fit to accede to this application in time for us to get the farm ready this season, we shall, by the end of next year, have established as a fact, that farmers can well afford to pay at least 2*d.* per ton for your sewage, and that by the time your Main Drainage Works are completed a demand for it will have been created which will absorb it as rapidly as the works for its distribution can be constructed. Thus the capital employed will become productive as fast as it is expended.

We have, &c.

(signed) *W. D. Starling*, Laurence Pountney-hill, E.C.
W. Westwood, Ventnor, Isle of Wight.
F. R. de la Trehonnais, Bickley-park, Bromley, Kent.
George Bait, Civil Engineer, 18, Great George-street, Westminster.

8, New-street, Spring-gardens, S.W.,
London, 26th Oct., 1863.

Utilization of Metropolitan Sewage.

Gentlemen,

In pursuance of our letter to you of the 1st of August, we have given careful consideration to the question of the London Sewage, and its most advantageous disposal.

At the time when we wrote that letter, we fully hoped that we should be able, by the present date, to lay before you the definite details of a plan, complete in every part.

With that object we have closely examined the matter in all its aspects, and the examination has but confirmed the doubt which induced us to delay where others had hastened forward; for we preferred to sacrifice priority of position if it was to be attained by incompleteness of information, and consequent crudity of arrangement.

It is not the magnitude of the contemplated work which has made us pause, but the conflicting nature of the opinions delivered by those who have devoted attention to the subject from a practical point of view, have convinced us that all the requisite information could not be brought together within the allotted time. Without full opportunity for thus bringing all the subject under review, the enterprise could not be effectually matured in all its details, nor the plans prepared in accordance with the Standing Orders of the House of Commons, if those plans are to be trustworthy, and adequate to meet the large, and we may add, the unprecedented requirements of the case. The same diffidence does not appear to have been felt elsewhere; but we feel satisfied that, although the needful information exists, and can easily be brought together, that essential preliminary has not yet been performed even by the public departments responsible for the ultimate execution of the work, much less by any private bodies who heretofore, have not either possessed the requisite authority and facilities, or even acknowledged the necessity for that preliminary labour. But while our inquiries have satisfied us on these negative points, they have also enabled us to arrive at distinct practical conclusions as to the best mode of dealing with the question before us—the economical application of the sewage, in a liquid form only, to useful and remunerative purposes.

The system which we should propose, subject to such modifications as might hereafter be found necessary, may be thus described:—

To erect at the seven stations marked on the plan sent herewith, and at others, if necessary, steam pumping engines of (say) a total of 3,500 H.P., capable of being doubled if required.

To receive the ordinary sewage from the main sewers at these stations, and to pump it thence through seven cast-iron main of 3 feet in diameter each, laid along the banks of the river, as shown on the plan; with provisions for interchange between the mains in case of accidents, thence to convey the sewage along the roads and railways to lands situate in the counties of Essex, Kent, Surrey, and Berkshire; to which lands, amounting to some 250,000 acres, it is proposed to apply the sewage partly from detached reservoirs, but chiefly by jets; finally, to construct as filters 500 to 1,000 acres of osier beds, through which to pass the sewage after it has left the other lands, in order fully to deprive it of all deleterious and injurious matters.

To provide against frost, and the consequent inability of much of the land to receive and absorb the sewage, partly by means of the osier beds above described, partly by the provision, annually, on the fallow lands of additional filter beds to the extent of from 500 to 1,000 acres, and partly by embanked water meadows.

To erect at each of the pumping stations, two covered settling tanks to receive the deposit of all heavy and insoluble matter intermingled with the sewage; one of these tanks to be in use whilst the other is being cleansed; this process being performed each morning before 8 A.M. The solid matter thus deposited, to be removed by water to suitable lands.

To allow the storm water to pass over weirs at the pumping stations down the main sewers to the main reservoirs provided by the Board, and thence to pump it through mains on to suitable lands on either side of the river.

We have ascertained that there are large tracts of land of small value within easy access of the metropolis, which greatly require improvement, and which are of amply sufficient area to absorb the whole of the sewage (taken at 80,000,000 gallons per diem) in an economical manner, as well as the whole of the storm water; and we hold that the comprehensive adoption of this principle, both in the metropolis and in the other towns connected with the Thames, can alone fully effect the object in view, the freeing of that river from the obnoxious and poisonous matters that now infest it.

It is obvious, that to deal with the case efficiently, the whole, and not a portion of the sewage of the metropolis, must be in the hands of one body; and that in securing the needful lands, the principle must be to obtain them on lease. Simply to supply the sewage to individual owners and tenants, as some persons have proposed, by means of local reservoirs and distributing pipes, is an arrangement that must lead to complication, and most probably to frequent litigation.

We would, therefore, propose that the Board should grant to us and to the gentlemen associated with us, a concession of the whole of the sewage for a period of 60 years from the completion of the works; the lease to be renewable at the expiration of that period, upon five years' prior notice, and upon terms to be agreed upon. We further propose that at the expiration of such period, should the concession not be renewed, the Board should purchase the plant of the Company, at a valuation. The concession to be in the first instance provisional, and to become absolute only upon the formation of the Company, and upon obtaining of the necessary Parliamentary powers for the execution of the works within two years from the granting of such concession.

A guarantee satisfactory to the Board, to be given upon the formation of the Company, for the due and proper carrying out of the necessary works; and two directors of such Company to be appointed by the Board.

The Company to have the use of the main sewers, reservoirs, and engine power of the Board, subject to the control of the engineer to the Board; and to have the assistance of the Board in obtaining the necessary lands, and in all other matters connected with their operations.

Upon such a concession being granted, we should propose to apply in the ensuing Session of Parliament for powers for the incorporation of the Company, the ratification of such concession, and for obtaining the necessary lands by consent.

The terms which we should propose for the concession to the Company, are as follows:

1st. If the sewage be not deodorised—That, during the term of the concession, the Company pay to the Board, as a consideration for the use of such sewage, such proportion of the net profits resulting from the Company's operation as shall represent a dividend of two per cent. upon the Company's capital, proposed to be fixed at 5,000,000 *l.*; provided always, that no such payment be made to the Board until the shareholders of the Company shall have first received a dividend of seven and a half per cent. upon the amount of the capital; the Board guaranteeing the Company against all actions brought against it for the use of such sewage.

2d. If the sewage be deodorised—and this we should propose to effect to the satisfaction of the Board, before the entrance of the sewage into the pumping wells—That the Company receive the sewage free of charge, and deodorise it; the Board paying one-half of the cost of such deodorisation.

We should propose in either case, that auditors be appointed by the Board to examine the Company's accounts, in conjunction with the auditors of the Company.

The Board in either case to provide land for the pumping stations, where such land is under their control, and in case of deodorisation to provide the necessary lands at Barking and Plumstead for the preparation of the deodorants.

We are, &c.
(signed) *Torrington.*
Charles Fox.
Thornton Hunt.

To the Commissioners of the
Metropolitan Board of Works,
Spring Gardens, S.W.

Dickleburgh, Norfolk,
20 October 1863.

Gentlemen,

I have the honour to acknowledge your letter of the 29th ultimo, and must beg your pardon for the delay, but it arrived when I was from home, and was put with the answered letters by mistake.

Gentlemen, I can convert the mud of the sewage to powder, in which state it would be portable and saleable at about 10 *s.* per ton.

I shall be happy to pay the Board a shilling per ton, or take a shilling per ton royalty for the use of my plans.

The only advantages I solicit over my competitors are—to be first on the stream, and the use of some few rods of land for plant.

If the Board approves these proposals, I shall be most happy to give fullest particulars.

I have, &c.
(signed) *Charles Johnson.*

8, New-street, Spring Gardens,
4 November 1863.

Utilization of Metropolitan Sewage.

Gentlemen,

Referring to our letter of the 26th ultimo, we think it desirable to further inform you that we should propose to guarantee the Board against any actions brought for the use of deodorised sewage, to provide a minimum of, say 10,000 acres per diem to receive the sewage, and not to apply the sewage to any lands situate within a radius of six miles from St. Paul's Cathedral.

As the time for giving the notices required by the Standing Orders of the Houses of Parliament is rapidly approaching, we should be glad to know the views of the Board as soon as may be convenient, in order that, should they desire it, the necessary steps may be taken for prosecuting a Bill in the ensuing Session of Parliament.

(signed) *Torrington.*
Charles Fox.
Thornton Hunt.

To the Commissioners of the
Metropolitan Board of Works,
Spring Gardens, S.W.

Spring Gardens, London,
7 November 1863.

Utilization of Metropolitan Sewage.

Gentlemen,

Will you kindly add to the first paragraph of our letter of the 4th, and consider embodied in such letter, the following words—

"And further to bind ourselves under a penalty of 10 *l.* per hour, for every hour during which the storm water shall be allowed to flow into the Thames, except in case of unavoidable accident to the machinery."

And oblige, &c.
(signed) *Charles Fox.*

To the Commissioners of the
Metropolitan Board of Works,
Spring Gardens.

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Correspondence.—Metropolitan Board of Works.

[*For the use of Members only.*]

26, Throgmorton-street,
Dear Sir, 15 February 1864.

I HAVE the honour to lay before you, for the information of your Honourable Board, the following few facts in reference to the value of the sewage for agricultural purposes. I fear the value of the sewage has been greatly overrated by Mr. Ellis and others, who have only taken their data from books, and without any practical experience of their own. It has been stated the sewage of London is worth 6 *d.* per ton. I think it must be obvious to all practical observers that this estimate is absurd in the extreme.

For instance, we will suppose a farmer wishes to get four crops of grass per annum from his meadow lands. The quantity of sewage for each dressing would be about 350 tons, or 1,400 tons for the four crops. Each crop of grass would average 10 tons, or 40 tons of grass. Then five tons of green grass is equivalent to one ton of hay, or eight tons of hay, then—

	£. *s.* *d.*	£. *s.* *d.*
To 1,400 tons of sewage, at 6 *d.* per ton.	35 – –	
To four irrigations, at 10 *s.* per acre.	2 – –	
To rent, taxes, and general charges for four crops.	10 – –	47 – –
Per Contra.		
By 40 tons of grass, or eight tons of hay, at 3 *l.* 10 *s.* per ton.		28 – –
Loss per annum to the farmer - £.		19 – –

I have given the above from facts, from land where the sewage is used as a manure, supposing the farmer had to pay 6 *d.* per ton for his sewage. At Rugby, Mr. Law states, that 1,500 tons of sewage to the acre increased the value of the produce from 11 *l.* 3 *s.* to 18 *l.* 14 *s.*, or 7 *l* 11 *s.* per acre; at this rate, the value of the sewage would only be worth 1¼ per ton.

Professor Way, the eminent agricultural chemist, estimates the extreme value of the sewage at 2 *d.* per ton. The Earl of Essex, whose experience with the sewage manure is very great, gives the same estimate as to its value per ton.

I may add, my own experience from the crops produced, in every way corroborates the accuracy of the above estimate of the value of the sewage per ton.

The average value of water (unmixed with sewage) for irrigation purposes is about ¼ *d.* per ton to the farmer. Now, if we take the entire sewage of London, north and south, at 728,000 tons per day, the amount of manurial matter, including excreta and urine, soap wash, wash and slops from the houses, &c., &c., would not exceed 15,000 tons per day; therefore, the amount of manure would be as 15,000 tons of manure to 428,000 tons of water. It will be readily understood from this, that the extreme value of the sewage will not exceed 2 *d.* per ton.

It may be said. But look at the value of the land where the sewage is already applied, at Edinburgh, the land lets at 30 *l.* per acre; at Mansfield, 12 *l.* 10 *s.* per acre; at Ashburton, Devon, at 6 *l.* per acre, &c., &c. I reply, this is all very true, but in these cases the farmer does not pay a single farthing for the sewage. The sewage flows over these lands without any cost whatever, and by gravitation, but if the farmers had to pay 2 *d.* per ton royalty for the sewage, this would reduce the value of the land to something like 4 *l.* or 5 *l.* per acre, and if more than 2 *d.* per ton was charged for the sewage, not one farmer could or would purchase the sewage, if it was even delivered into his field.

The cost of laying down the irrigating works on the plan I have now the honour of laying before your Honourable Board will not exceed 2 *l.* 10 *s.* per acre on part of our Company, and 10 *s.* per acre on part of the farmer; at this rate, by charging the farmer 2 *d.* per ton for the sewage or manure, it will pay an ample dividend both to the Company for laying down the irrigating works, and also return a fair amount to the ratepayers per annum, when the works are in operation to apply the sewage to its fullest extent.

But I would most respectfully suggest that, in granting the concession of the sewage for London, that the price at which the sewage manure should be sold to the farmers should be left an open question, to be decided from time to time, according to circumstances, by your honourable Board and the Board of Directors of the Company; by making a provision of this kind, the interests of all parties would be amply protected.

I have, &c.
(signed) *George Shepherd*, C. E.,
Engineer to the London, Midland
Counties, and General Sewage Irrigation
Company (Limited).

J. Pollard, Esq.,
Clerk to the Metropolitan Board of Works.

To the Honourable Chairman and Members of the Metropolitan Board of Works.

Gentlemen,

At the interview afforded me by the Committee on the 23d instant, some particulars were referred to which I beg leave further to explain. My tender of 5th July 1860, for the sewage was referred to, requiring the sewage for the first 14 years on a pepper-corn rent, or free from any pecuniary payment to the Board, as if our Company would have all the profits during that period; whereas, when making that proposition, I took into consideration (if then acceded to) the length of time that would elapse before any return could be had from the consumers of the sewage, and which I fully explained in my letter of the 10th of the same month, therefore it was not from a desire to obtain any profit from the sewage without the Board of ratepayers participating in the same, but to prevent the Company having to pay for an article before any return could be had therefrom. The deferring concession by the Board has so altered the time as to be otherwise arranged, by making the payments from the Company to commence on their receiving a profitable return for the sewage.

The Committee also referred to my subsequent proposal to pay the Board one farthing per ton for the sewage, and their engine power to be employed in raising it to the elevation necessary for the land proposed to be supplied, and that the same would realise for the Board about 136,000 *l.* a-year, one half of which the Board would receive as value for the sewage, as the expense of raising it to the required height would not cost more than one eighth ($\frac{1}{8}$ *d.*) of a penny per ton. As my reply to the Committee "that it might cost the Company from one eighth ($\frac{1}{8}$ *d.*) to a farthing ($\frac{1}{4}$ *d.*) per ton to raise the sewage to an elevation of 200 feet," may be misunderstood, it is necessary that I should explain more particularly this part of the subject.

In my letter of 6th February 1862, the lands I had proposed to be supplied with the sewage are stated to range from 10 feet to about 150 feet above Trinity datum, and to those portions at the extreme height, with the power to overcome friction and secure free delivery, hydraulic pressure equal to 200 feet would be required; although the maximum is 200 feet, the average power required will be only equal to about 120 feet of hydraulic pressure, and this can be effected by the Company for one-eighth ($\frac{1}{8}$ *d.*) of a penny per ton, including costs of engines, coals, &c., and can be effected by the Board for less than that, as they are to have a surplus of engine power which can be available for the purpose.

As to the quantity of sewage per acre which I stated to the Committee to be used as manure, and that it would vary from 1,000 to 5,000 tons per acre annually, according to circumstances, and although much less than 1,000 tons per acre annually could not be considered a sufficient manuring of land, yet in extreme dry weather, even 100 or 200 tons per acre would produce a beneficial effect as a watering on any crop; and the greatest advantage derived from the application of manure in a liquid state, is, that it can be applied both as food and drink to any crop during all stages of its growth. But the small quantities of sewage proposed by some parties as a sufficient manuring of land, or food for the crops, prove conclusively their want of experience in agriculture, and total ignorance of the subject, being contrary to all the facts of the case.

As there have been several crude schemes for the utilization of the sewage of the metropolis laid before the Board for consideration, by persons who have had no practical agricultural experience on the subject, but have compiled the ideas of others; it may not be considered obtrusive in a person who has had 40 years' experience in the science and practice of agriculture, and particularly in the application of manure in a liquid state, to suggest the necessary requirements for the successful and profitable application of sewage to the land, which may prevent such a failure in the operations thereof as that of the Metropolitan Sewage Manure Company, who would have been eminently successful if they had complied with the experience of those who got up the Company.

1st. It is of the greatest importance that sewage should be conveyed in a continuous flowing state from the source of supply to the land in which it is to be absorbed, as the impounding of it in tanks or reservoirs induces decomposition even in a very few hours, which not only deteriorates the materials, by throwing off one of its most valuable fertilisers (ammoniacal gas), but also produces other gases that are objectionable in a sanitary point of view, and although deodorisers or disinfectants may be used when so impounded, their effect as such soon ceases, and always deteriorates the fertilising qualities of the material. Whereas, when the sewage is in a continuous flowing state, no decomposition takes place and it is much less offensive to the smell than solid manure, and it is only in very warm weather that deodorisers would require to be used, as the soil is the best disinfectant.

2d. The locality for its application is of great importance to secure a profitable return, particularly for the sewage of the metropolis, as the expenses to be incurred to convey it to suitable land will be much greater than if it flowed there by gravitation, and it is only to a very limited distance from the source of supply that it can be made profitable, as the expenses that would be incurred by conveying it to any great distance would be greater than the value of the produce derived therefrom, at such a distance from where consumption could be had for so great a quantity.

The high rent (from 20 *l.* to 40 *l.* per acre) obtained for the Edinburgh meadows, is in consequence of their being very near the city, affording the dairymen the convenience of feeding their cows, by cutting the grass several times during the day, and feeding them with it green and fresh from the scythe.

The produce of grass, from five to eight cuttings in the year, weighing from 40 to 80 tons per acre, according to the favourableness of the season, and being of the value of from 10 *s.* to 15 *s.* per ton, according to the supply and demand, or consumption of such produce; from which it must be evident that the expenses of conveying such a quantity to any considerable distance, would so increase its price to the consumer, or reduce the price for the producer, as not to be suitable for the purposes for which it would be available if consumed near where it is produced.

Besides which, if conveyed in bulk to any distance that would require some hours for such conveyance, heat and incipient decomposition would

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I have, &c.
(signed) *John James Moore.*

6, Pump Court, Temple,
25 February 1864.

6, Duke-street, Adelphi,
19 March, 1864.

To the Metropolitan Board of Works.

Gentlemen,

Referring to the conference which I had the honour to attend on the 23d ult., at which it was suggested that a portion of the sewage of London might be made available for treatment by my system, I beg leave to say that, without derogating from my tender of the 6th May last, if adopted in its integrity, I am prepared to modify my tender, if desired by the Board, in conformity with their suggestion.

There would be great difficulty, if not impossibility, of combining either of the other two principal systems with mine, so that I venture to assume that if my plan be partially adopted, it would be for the Southern Outfall at Crossness, where in case I can acquire sufficient land, by purchase or otherwise, my works should be erected.

I need not at present enter into details, but it will be obvious to the Board that the conditions of the original tender will be subject to variation, particularly as being required to acquire land for the purpose of my operations beyond the sphere of the Board's Parliamentary powers; the claim of forfeiture of plant, works and machinery, would naturally be confined to such as would be erected by permission of the Board on its own premises.

With regard to the suggested variation of my stipulated gratuitous term of probation for seven years, I must respectfully submit that for commercial purposes, that condition is necessary, because the market for disposal of the stuff has to be made, and experience has shown that one of the principal causes of failure in Sewage Companies, particularly that of Leicester, has been the impossibility of forcing sales.

In event of the adoption by your Honourable Board of this as a general basis of negotiation, I shall be prepared to submit for consideration, a tender of terms, to be substituted for my original proposal, with all promptitude possible.

I wait your reply, and have, &c.,
(signed) *C. F. Kirkman.*

6, Duke-street, Adelphi, W.C.,
Dear Sir, 18 April 1864.

I have the honour to acknowledge the receipt of your esteemed favour of the 15th instant. In answer, I beg to say that, with the opportunity so obligingly offered for correction of proofs, in order to preclude any omission or misadvertence of form, I can have no objection to the course proposed by your Board of printing the questions and answers of the conference, referred to in your letter, when I had the honour to attend the Board on the 23d of February last.

In pursuance of the permission your communication gives for presenting further proposals, as suggested by my letter of the 19th March, I take the liberty of submitting for the consideration of the Committee of the Board, the alternative offer of terms by which I am prepared to abide, in conformity with the suggestion of the Committee for limiting the application of my system to a reduced area of the Metropolitan district.

I do not think it necessary to extend my explanations, being convinced that no theoretic handling of the subject can satisfactorily establish a fair basis of comparison. Nothing, in my opinion, but the practical test of experience will meet the requirement of the case; and I am equally convinced that my proposal affords the equitable and effective means of applying that test, without protracted delay and overwhelming loss of capital.

The suggestion is in complete harmony with my own desire for a gradual development of my plans, in the possible event of their successful trial justifying the unreserved adoption of the system by your Board; therefore, I cheerfully submit to the wishes of the Committee, in modifying the scope of my tender to the terms applicable to the Southern Outfall, without prejudice to my original tender, in case the Board should deem it expedient to apply the same system to the entire Metropolitan Drainage.

I have, &c.,
(signed) *C. F. Kirkman.*

To John Pollard, Esq.,
Metropolitan Board of Works.

Alternative Tender for The Metropolitan Sewage of the Southern Outfall at *Crossness.*

6, Duke-street, Adelphi, W.C.,
Gentlemen, 18 April 1864.

Referring to my original tender of the 6th May, 1863, renewed by supplementary tender of the 6th July, 1863, as also to the remarks in regard to that proposal at the conclusion of my letter of 3d February last, of my letter of the 19th of March last, and of this date, with regard to the modifications of my tender herein contained, I propose to your Honourable Board the present alternative, in regard to the reduction of the area of application of my system to the Southern Outfall at Crossness, in conformity with the suggestion made at the conference I had the honour to attend on the 23d of February last.

1st. The duration of the contract to be 21 years from the completion of the works, which will be ready for use within one year, and completed according to specification within two years from the date of contract.

2d. Such land and water frontage as may be in the possession or power or procurement of the Board, necessary and available for the purposes of the concession, shall be granted to me for requisite user during the concession.

3d. The sewage from the Outfall at Crossness shall be delivered to me as may be agreed.

4th. During the first seven years of the above term of 21 years, a nominal rent to be reserved, but subject to payment as after mentioned of rent and royalty for the remaining period of 14 years.

5th. I agree, pending the concession, to take, deodorise, and utilise the sewage by separation, diverting only the aqueous portion, in an inoffensive and innocuous state, through channels to be provided by the Board for discharge into the river, if necessary, and to affect the manipulation and removal of the solid matter without nuisance.

6th. The following rents and royalties are to be paid by me to the Board, without any responsibility on its part:—

For the first septennial period, a pepper-corn rent, as for a probationary and experimental term.

For the second septennial period, the minimum rent of 2,500 *l.* per annum, to be increased by a royalty of 20 per cent. of the net proceeds, after paying to my shareholders a dividend of 20 per cent. on the capital of the company subscribed or borrowed.

For the third septennial period, the like minimum rent of 2,500 *l.*, to be increased by a royalty of 20 per cent. of the net proceeds, after paying to my shareholders a dividend of 5 per cent. on the capital subscribed or borrowed.

7th. In case the Board should hereafter desire to determine the concession on any other ground than cessor or forfeiture for non-performance of conditions on my part, I consent to a surrender of the same on two years' notice, subject to the repayment of the capital invested, with the addition of 25 per cent. premium, and the payment to myself or my representatives of a royalty of only one per cent. for the use of my system while my patents last.

8th. All erections made by me on the premises of the Board are to pass to the Board in the event of cessor or surrender.

In conclusion, I have only to state that I have reduced the minimum rent of my original tender, stated at 10,000 *l.* per annum for the whole sewage, to the rent of 2,500 *l.* per annum for the Southern Outfall sewage, on the supposition that the contents are about one-fourth of the entire produce of the Metropolitan drainage. I have estimated this minimum rental on the basis of my Leicester concession, mentioned in my letter of the 3d February last, and it is all the more favourable in the present case, inasmuch as all works and deodorization are provided for me at Leicester, for which I have to furnish the requisite outlay on a much more expensive scale for the Metropolitan Works. There is this distinction further in favour of your Board, that the rental of the Leicester sewage is fixed at a certain figure, without any increase in proportion to proceeds, while my tender guarantees to the London ratepayers an augmenting revenue, which, according to the estimate of Volcher and others, may amount to a very bountiful compensation for the drainage of South London alone, namely, from 20,000 *l.* to 50,000 *l.* per annum clear income.

In addition, I venture to call attention to the evidence of Mr. T. A. Hanson and associates, before the Sewage of Towns Committee 1862 (2d Report, 29th July 1862, page 21 of Minute, 2608):—

"Are you prepared to pay anything for the privilege of taking the manure, or do you consider that you ought to have it given to you, you performing in return the service which you have mentioned, for nothing?—When, in Manchester, they pay perhaps 8,000 *l.* a-year for removing it, we think if we do it for nothing, it is of itself a good remuneration."

If the circumstances of the Metropolitan drainage allow, without the cost entailed on Manchester, the diverting of the stuff into the tidal way of the Thames at the outfalls, on the theoretic possibility of its total removal by the tide—which I make bold to call in question, in the full belief that a vast portion would be thrown back upon the upper banks of the river—there is this in my proposal which is favourable in weighing such evidence, that a vast material is preserved for increasing the fertilising agencies of agriculture, and that there is a certain minimum guaranteed for annual expenditure by the Board, for supervision and other purposes; and in due course, there is little doubt a largely remunerative return will be derived by the ratepayers, and the term of concession I ask is so short, that a considerable advantage is insured by this proposal in regard to ulterior operations.

I have, &c.
(signed) *C. F. Kirkman.*

To the Main Drainage Committee of the
Metropolitan Board of Works.

Utilization of Metropolitan Sewage.

8, New-street, Spring Gardens,
Gentlemen, London, 31 March 1864.

In accordance with the wish expressed at our interview with your Main Drainage Committee on the 8th instant, we have carefully re-considered the propositions contained in our former communication of October 26th 1863, and having done so, we adhere to the general principles contained therein, as to the mode of dealing with the sewage, as follows:—

To intercept the ordinary sewage at seven or more points to be approved by the Board; to erect at these points pumping engines of a nominal power of 3-500 horse-power, with arrangements for duplication, in the very probable event of its necessity, with two covered settling tanks to receive the deposit of all heavy and insoluble matter at each station, one tank being in use whilst the other is cleansed, and the solid matter removed by barges or otherwise.

To pump the ordinary sewage through mains along the banks of the River Thames, and thence along the roads or railways to lands situate in the counties of Essex, Kent, Surrey, and Berkshire, and in every case more than six miles distant from St. Paul's Cathedral.

To provide an area of, say 250,000 acres, for the reception of the sewage, partly from detached reservoirs, but chiefly from distributing pipes and jets, and to make proper arrangements for the efficient drainage of the land thus provided, partly by osier beds, and partly by subsoil drainage, providing a considerable area of reclaimed water meadow, and also of osier beds, for the absorption of the sewage in time of frost. The company would propose to obtain these lands generally by purchase, or on lease.

We would submit the following terms upon which we think the concession should be granted to us, and the gentlemen associated with us.

That the Board should grant a concession of the whole of the sewage for a period of sixty years from the completion of the main-drainage works, such concession to be renewable upon the expiration of such period, upon five years' prior notice, upon terms to be agreed upon; or failing, agreement to be finally determined by the then President of the Board of Trade. Should the concession not be renewed, the Board to purchase the plant of the Company at a valuation, if so required by the Company. The concession to be, in the first instance, provisional, and to become absolute only upon the formation of the company, and upon the obtaining of the necessary Parliamentary powers for the carrying out of the objects of the company, within two years and a half from the date of such provisional concession.

That a guarantee satisfactory to the Board be given upon the formation of the company for the responsibility of the said company, and the due and proper carrying out of the works.

That the Company have the use of the main sewers, reservoirs, and engine power of the Board, subject to the control of the engineer to the Board, and have the assistance of the Board in obtaining the necessary lands, and in all matters connected with their operations.

That the Company shall be at liberty to use such portion of the sewage as they can employ profitably, allowing the rest to flow into the Thames.

That the Company shall remove the solid matter from the pumping stations to be erected by the company, and leave such portion of the same as they shall not require at the outfalls, to be disposed of by the Board.

That in consideration of the foregoing proposed concession, the company shall pay to the Board for the use of the sewage as aforesaid, the fixed annual rental of 10,000*l.*; but inasmuch as the profitable use of such sewage by the company must necessarily be deferred during the construction of their works and the development of their operations, for a long period after the necessary Act of Parliament shall have received the Royal Assent, we propose that the said company shall pay in and for the sixth year after such Royal Assent shall have been received, the rental of 2,000*l.*; in and for the seventh year, the rental of 4,000*l.*; in and for the eighth year, the rental of 6,000*l.*; in and for the ninth year, the rental of 8,000*l.*; and in and for the tenth, and every subsequent year during the continuance of the said concession, the full abovenamed rental of 10,000*l.* And we further propose that such rentals shall be secured by a first charge upon the lands of the company, and shall be recoverable by distress in the same manner as rent in arrear.

That as the said company will contribute in so large a sum to the annual income of the Board, provision should be taken in the Act of Parliament of the said company for the appointment by them of two additional members of the Board, to represent their interests thereat.

Upon such concession being granted, we should propose to apply in the ensuing Session for the necessary Act for the incorporation of the company, for the ratification of such concession and the provisions thereof, and for powers to enable the company to make use of the sewage of the Metropolis as proposed by them; to obtain by consent and to hold the necessary lands for the reception of the sewage and for cultivation, and to obtain compulsorily the necessary lands for their pumping engines, pipes, &c.

We have also to request that in the event of such concession being granted, the fact should not be published by the Board for the present, inasmuch as such publication would seriously interfere with our endeavours to obtain provisional contracts for the purchase of land for the operations of the company.

We have, &c.,
(signed) *Torrington.*
Charles Fox.
Thornton Hunt.
B. Smith.

Wilkinson, Stevens, & Wilkinson,
Solicitors to the proposed Undertaking.
To the Commissioners of the
Metropolitan Board of Works,
Spring Gardens, S.W.

2, Old Palace Yard, Westminster, S.W.,
29 April 1864.

Sir,

We are reminded, by Mr. Pollard's letter of the 14th April, of the promise which we gave to the Board, at our interview on the 23d February last, to supply them with further information as to the practical carrying out of the scheme which we have had the honour to submit to them for the utilisation of the sewage of the northern area of the metropolis. We much regret the delay that has taken place, but an unusual press of business has rendered it wholly impossible for either of us to devote to the subject the time and attention which it deserved.

In Mr. Pollard's letter, he informs us that it is proposed to print the several questions which were put to us when we attended the Committee of the Board, together with the answers given thereto.

As, however, so long a time, more than two years, had elapsed since our former interviews with the Board, and as Mr. Hemans, our engineering adviser, was unable to accompany us when we attended the Committee, we were in a certain degree unprepared, and, if you would permit us, would rather substitute for those questions and answers the more ample details and explanations which we now have the honour to submit.

When we first embodied our scheme in formal propositions to the Board, in the year 1861, we were not in possession of a great deal of information which has since been supplied to us, and been placed at our command from various sources; and, in consequence, though the conclusions we arrived at were perfectly sound and true, as far as they went, they did not comprise the whole truth. We had inquired into the practical results of the various systems of utilising sewage, on which practical experiments had been made, namely, ordinary irrigation by means of surface channels, watering through the hose and jet; first, in its natural state; secondly, after an imperfect process of deodorizing, and also the various systems of precipitation reducing the manurial elements into a more or less portable or condensed form.

We found that all the first scientific men of the day, as well as all the practical men of a really large and reliable experience, were agreed that of all

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all the systems proposed and experimented upon, one only was applicable on a large scale, had stood the test of time, and could be relied upon as remunerative under all circumstances. This system was that which chance had pointed out to the fortunate proprietors of the Craigentinny Meadows, near Edinburgh, of which there are unbroken records for more than 60 years, and to which it appears they have applied sewage more or less regularly for nearly three centuries; this scheme, supported as it was by science and experience, we adopted; and though, so far as it goes, it is perfect and complete, though the results may be calculated with certainty, and the produce estimated by a simple rule of three sum, an attentive consideration of all the evidence adduced before the Parliamentary Committee, for whose report the Board adjourned their decision upon our scheme, has, nevertheless, shown us, that by sacrificing the maximum results to be obtained from a limited space of ground, we may in reality obtain from an intermittent application of sewage over a more extended area, a larger pecuniary profit.

It is a common saying, that anything may be proved by figures or statistics; and, in a question involving so many engineering, agricultural, financial, and sanitary considerations, it is only natural that the statistics should be peculiarly complicated and involved. It is perfectly true, that the system followed with such unvarying and practical success at Craigentinny is the best system; it is also true that no other system taken by itself is, on a large scale, at all events, either sound or practical; but further and closer study of the subject, in all its bearings, has shown us that the greatest pecuniary results are to be obtained by the partial engrafting on to the Craigentinny system of some others, which have met with partial success on a small scale.

When the general problem is discussed, of how to dispose of the vast quantity of sewage termed by the engineers "the ordinary dry weather discharge," and estimated by them for the northern area of the metropolis at ten million cubic feet per diem, it is clear that no system is applicable which is not by itself capable of absorbing and utilising in a rough, practical, and economical manner every day in the year, and in all weathers, the whole of this vast quantity of liquid. The idea of distributing the whole of these ten million cubic feet daily, through an immense complicated network of pipes, to be applied to the soil through the hose and jet, is one that no practical man can for a moment entertain. The capital required for the pumping machinery, and for the thousands of miles of pipes, and the daily labour and expense of application, would be so enormous that, even could it be obtained, no return that the land could give would pay the cost; but a much more fatal objection to any attempt is the fact that this great body of liquid is, like a river, constantly flowing onward, and requires, therefore, a constant, free, and unchecked outlet, which no system of pipes, however extended, could supply; they would require to be supplemented by an overflow for the discharge of the waste which would be constantly taking place. The system which we propose affords the steady, constant, and unceasing demand which is absolutely necessary to meet so steady and constant a supply. But though it has been proved by the practical experience of years at Craigentinny, and by the careful scientific experiments conducted at Rugby and elsewhere by the Royal Commission, presided over by Lord Essex, that, taken by itself, no system of sewage application will pay on a large scale but that which we have adopted, and that the return of produce is in direct proportion to the quantity of sewage applied. We have, nevertheless, come to the conclusion that this system, so perfect in itself, may be made still more remunerative if supplemented by others; and that though this system gives out the full value of the fertilising properties contained in the sewage, which no other system, taken by itself, will do, yet we see, paradoxical as it may appear, that under certain circumstances a fictitious value may be obtained for the sewage by its partial and temporary use on soil not wholly devoted to it. The truth is, that the very form in which sewage presents itself to the experimental agriculturist, and which forms the great obstacle to its useful application, may, under certain circumstances, be made useful and profitable.

In examining the different systems of sewage utilisation, the first and most difficult problem which presents itself is, how to dispose of the enormous volume of water with which the fertilising substance is diluted. The manurial constituents of sewage are suitable for every description of crop. Professor Way, in his answer to Question No. 774 of the Select Committee of the House of Lords on Town Sewage, says: "If you gave me dried sewage, it would be capital manure for any crop, no matter whether wheat, or green crops, or grass; it is merely the form in which you present it that makes it unsuitable for some crops. It strikes me that it is the same kind of thing as if a man were to owe me the value of an ounce of gold, and were to bring it to me in the shape of gold quartz, saying, 'Here is so much gold quartz, which contains 4*l.* 15*s.* worth of gold,' or whatever it may be. That would not be paying me at all; I should have to take it with all its disadvantages, and to get it out of the quartz." But this same quality of sewage which constitutes the greatest drawback to, and even renders impossible, its useful application to many crops, under certain circumstances may, on the other hand, itself be utilised and even rendered highly profitable under opposite circumstances. An enterprising farmer in a dry district of the country, where, for instance, the rainfall is no greater than on the Essex shore of the Thames, would willingly pay a considerable yearly rental for the power to apply to his crops, at the critical moment, several successive dressings of liquid manure by some comparatively economical agency.

We have, therefore, so far modified our scheme that, instead of making the chief object of it the application of sewage on the Craigentinny system to the flats and sands on the coast of Essex, we now look more extensively to the partial and intermittent application of sewage over the southern and eastern portions of the country for a very large portion of our profit.

Such an extensive use, however, of the sewage as this implies can only be brought about by time. For the first few years after the completion of our main sewer, we can hope but for little profit from this source; the general introduction of so expensive a novelty, among a class so proverbially conservative and opposed to innovation as farmers, must be very gradual. The capital advantage of our scheme over all others, continues still to consist in the fact, that, we can with certainty take and utilise every day in the year, and in all weathers, the whole of the prodigious discharge, which

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which the officers of the Board estimate at ten million cubic feet per diem. We can, sir, not only utilise daily this vast quantity of liquid, but, as is proved, by the experiments before alluded to of Lord Essex's commission, we can extract the full value of the manurial constituents of the sewage; we are not dependent on the good-will and pleasure of a great body of farmers, who would certainly, one and all, refuse to take the sewage in wet weather, nor are we dependent upon any complicated machinery for its distribution, nor, again, are we dependent upon a capricious market with fluctuating prices, as would be the case did we precipitate and condense the sewage, nor can we be exposed to competition. In the Maplin Sands we have an extent of ground sufficient to absorb, filter, and utilise the entire body of sewage throughout the year, and the results of this application will be as steady and unvarying as the supply itself. We propose, as you are aware, to confine our produce to one crop, namely, grass, as at Craigentinny; of this we shall probably have many different varieties, some being suitable as food for cows, others for fattening cattle, and others for converting into hay. The result in produce can therefore be easily calculated; our doubts are only as to the value into which we may be able to convert this produce. As we have also infromed the Board we intend to divide the area of the Sands into dairy farms of convenient sizes, and the produce to be obtained from this area will be sufficient to afford to the inhabitants of London such a supply of pure, wholesome, and unadulterated milk, and other dairy produce, as they never can obtain from any other source. But we are aware that, in the first instance, we shall have very many great and serious difficulties to encounter, the opposition and competition of existing dairy farms, and establishments in and around London, the hesitation which most of the proprietors of these will feel in transplanting their stock to our ground, and the proverbial difficulty which the attempt to divert trade and commerce of all kinds from their accustomed channels always encounters.

These, sir, are the sources of uncertainty which our scheme presents, and these are the reasons why we stated to the Committee that our scheme was, to a certain extent, an experiment; but these are, on the other hand, the only sources of uncertainty, and there can be little doubt that the traders in dairy produce in London, where the principles of commerce are so thoroughly understood, will soon abandon all attempt at competition and opposition, and come to us in order to be able to "buy in the cheapest market." Our scheme may, to a certain extent, and in this sense, be an experiment, but as regards the chemical, agricultural, and economical principles on which it is founded, it is no experiment; and this, at least, is very certain, that every other scheme which has been submitted to the Board is an experiment in every sense of the word, and not one of them is founded upon any reliable practical experience at all.

We have, sir, already stated that we have, to a certain degree, modified our scheme as originally submitted to the Board, and we have indicated the reasons and object of such modification. We will now proceed to explain practically the nature of these modifications. In our original scheme, we contemplated an expenditure not far short of two millions sterling, in the reclamation of both those portions of the coast of Essex, known as the Maplin Sands and Dengie Flats. Though these two foreshores of the coast of Essex are contiguous, and, indeed, only divided by the small and unimportant River Crouch, their nature is entirely different. The Maplin Sands are, comparatively, as their name indicates, pure sea sand; they contain, indeed, only a very slight admixture of other elements, and are also as perfectly even and regular as if they had been artificially levelled; the inclination towards the sea is also so slight as to be scarcely appreciable to the eye; they are, in fact, naturally much in the condition to which the portion of the Craigentinny Meadows next the sea has been artificially reduced; they, therefore, require the minimum expenditure after their protection from inundation to prepare them for irrigation. The Dengie Flats, on the other hand, are as irregular on their surface as the Maplin Sands are smooth; they are, moreover, chiefly composed of a soft, sticky mud, which would render the labour of their levelling and preparation doubly expensive. After mature deliberation, therefore, and after consultation with various scientific as well as practical agriculturists, we have decided on abandoning the idea of extending a branch of our sewer across the Crouch; and we are supported in this view by our engineering adviser, Mr. Hemans, who has, with our consent, undertaken the reclamation of these flats for ordinary agricultural purposes under another company.

The area of the Maplin Sands is by itself greater in proportion to the quantity of sewage available from the northern area of the Metropolis, than are the Craigentinny Meadows to the sewage conveyed to them from Edinburgh by the "Foul Burn." We have, therefore, still the certainty of being able usefully to absorb the whole of the sewage of the northern area, which the Main Drainage Committee, by their decision of the 10th January 1862, recommended the Board to place at our disposal; while, on the other hand, this modification of our scheme presents the very great advantage of enabling us to reduce very considerably the capital upon which the shareholders of our proposed Company must receive a high rate of interest before the Board could participate in profits derived from the undertaking.

As we had the honour of stating to the Committee at our interview on the 23d February, we do not intend to burthen the Company, and therefore indirectly the Board, with the large expenditure necessary for the eventual distribution of the sewage over so large a portion of the county of Essex, as we hope, eventually to supply. Through the agency of the Lands Improvement and Land Securities Companies we shall be able to supply the whole of the capital for the works which this extended use of the sewage may, from time to time require, whatever its amount may be. The share capital of the Company may be, indeed, reduced to two-thirds of the cost of the main sewer from Abbey Mills to the present high water-mark upon the Maplin Sands, and of the sea embankments necessary for the reclamation of this area, together with two-thirds of all expenses connected with these works. The remaining third may be raised by debentures, and the whole of the expenditure necessary for the preparation of the ground for irrigation, and the erection of suitable farm buildings, may be supplied through the machinery of the two above-mentioned Companies. The cost of the capital obtained by these two latter means will be so much less than that of the nucleus of share capital necessary as a foundation, and

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and the share capital will, by these means, be reduced to so much smaller a figure, that the participation of the Board in the profits of the undertaking will not only be very much greater, but will also commence at a much earlier date.

We no longer consider it necessary, either, that the share capital should receive 10 per cent. in addition to half the surplus profits. We consider that our calculations are now so fully borne out by the evidence given before the Select Committee, that it would be sufficient to promise the share capital half the net profits, with a minimum of 10 per cent., to be made good, if necessary, out of subsequent years.

The contractor's estimate for the engineering works—that is to say, the main sewer, principal irrigating channels, pumping machinery, and embankments—together with interest and management during construction, comes to 1,500,000 *l.* The subsequent preparation of the soil, and erection of buildings, may be safely estimated not to exceed an average expenditure of 20 *l.* per acre, or the total sum of 240,000 *l.* for the whole area.

The theoretically realisable value to be obtained from a regular and systematic application of sewage to the extent of 10 millions cubic feet per diem (the estimated quantity to be placed at our disposal), is proved by the above calculations to be from 422,452 *l.* 10 *s.* 5 *d.* to 516,660 *l.* a-year, or an average of 464,025 *l.* This, deducting 30,000 *l.* for expenses, labour, maintenance, wear-and-tear of works, management, &c., will leave a sum of 434,025 *l.* as the net proceeds available for the annual charge on account of the debentures, namely, 27,500 *l.*, and 16,080 *l.* in satisfaction of the rent-charge created on account of the farm buildings and other agricultural works, leaving an ultimate balance of 390,445 *l.* to be divided between the shareholders and the Board.

Whether we shall be able immediately to realise this theoretical value of 434,025 *l.* a year from the Maplin Sands, when reclaimed, it is impossible to say, as this must depend on the amount of opposition and obstruction offered on the part of the dairy-farmers and traders; but on the other hand, as it is our intention, at various points along the line of the main sewer, to irrigate a few sample meadows, as an advertisement to the surrounding farmers of the fertilising properties of sewage, there is every reason to believe that we may, even before the expiration of the first season, be able to distribute a considerable portion of sewage over the farms nearest the conduit, and thus obtaining for this portion of the sewage a fictitious value, as we have already explained, the total pecuniary result realisable even the first year may, after all, not fall very far short of the theoretical value which we ought to obtain, and it is clear that the returns derivable from all sources must for many years continue steadily and rapidly to increase.

The one great and exceptional advantage of our original scheme for the application of the sewage solely to the foreshores of Essex, namely, that we propose to carry it altogether beyond the utmost limits of present habitation, entirely preventing the possibility of its influencing any rivers, springs, wells, or water-courses, is still in a great measure applicable to our scheme as matured and developed, as it is still upon the same foreshores that we contemplate applying the main body of the sewage; and as the amount to be placed at the disposal of the farmers will be limited, and as they will generally avail themselves of it only in dry weather, it is in the highest degree improbable that any nuisance can arise from this more extended system which we now contemplate.

We trust, sir, that the further information now submitted to you will prove in every way satisfactory to the Board, though, should any of the members desire further explanations upon any points, we shall have much pleasure in furnishing them; but as our time is very much occupied, and as Mr. Hemans is at this season constantly engaged before Parliamentary Committees, it would be almost impossible for us all three to be able to attend a meeting of the Committee. We would, therefore, venture to request that, in the event of the Committee desiring any further explanations, Mr. Pollard be requested to submit the questions to us in writing; and, indeed, it would probably be also more satisfactory to the Board that we should furnish them with the desired information in writing, though, as in the present letter we have endeavoured to touch upon all the practical bearings of the question, we should imagine that any further information which the Board may desire will rather be of a scientific nature for Mr. Hemans than of a practical nature from ourselves.

Feeling that this question has now been thoroughly ventilated, and seeing that the evidence of every description adduced before the Select Committee of the House of Commons, and all subsequent information obtained on this subject, has in such a singular manner justified the recommendation of our scheme to the Board by the Resolution of the Main Drainage Committee of the 10th January 1862, stating, "That the Committee entertain very favourably the proposition for dealing with the sewage of the northern area of the metropolis, contained in the communications from the Honourable William Napier and William Hope, Esq.; and recommend the Board to assent to the principle of a concession of the sewage for a term of 50 years, provided the requisite authority be granted by the Legislature to the Board, and subject to the introduction of all necessary clauses in the Bill for the protection of the Board and of the public interests confided to them, and for ensuring the fulfilment by the Company of the obligations undertaken by them;" we now confidently look forward to obtaining very shortly the final decision of the Board, enabling us to proceed with this great and useful undertaking.

We are, &c.
(signed) *W. Hope.*
William Napier.

John Thwaites, Esq.,
Chairman of the Metropolitan Board of Works.

Appendix (A).

It would seem at first sight to be a very simple affair to ascertain the value of sewage; and indeed so it is, in one sense. The theoretical value of the manurial constituents of sewage has been very accurately ascertained by the careful experiments of analytical chemists.

See 1. Professor Voelckler's article in Morton's Cyclopædia of Agriculture.

2. Mr. Bennet Lawes' Table, given in his paper read before the Society of Arts in 1855.

3. Dr. Angus Smith's Tables, prepared for the Board of Health.

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4. The analysis of Dr. Anderson of Edinburgh.
5. Of the late Mr. Phillips, of the Museum of Economic Geology.
6. Of Mr. Lindsey Blyth.
7. Of Professor Letheby.
8. Of Dr. Odling.
9. Of Dr. Hofmann.
10. And, finally, the numerous analyses and experiments of Professor Way, some of which were embodied in his article on "The Use of Town Sewage as Manure," in the Journal of the Royal Agricultural Society for 1854.

From these various sources it appears that the theoretical value of the manurial constituents of sewage is on the average 6 *s.* per annum per head of population; but this is the value calculated as if the several constituents were in the most condensed, portable, and economic form, and we have seen that in sewage, on the contrary, they are presented to the ordinary farmer in a most objectionable form. The question is, then, how to apply the sewage, and what crops to apply it to, so as best to realise the theoretical value; and this, it is evident, is a very complicated question.

A supply of liquid sewage, amounting to 10,000,000 cubic feet per diem, is not a thing that can be sold in the market like guano, superphosphate of lime, or nitrate of ammonia. These are condensed and portable; they can be easily housed and stored at seasons of the year when the demand is slight, and can be transported economically and profitably to the most distant parts of the country. But the enormous volume of water with which sewage is diluted alike forbids the possibility of storing it, and of distributing it over any great extent of country, or by any ordinary means of transport. Each day's supply must be sold and disposed of in the 24 hours.

It must also be made the vehicle for its own distribution. The notion of conveying 10,000,000 cubic feet, or 277,777 tons, daily in covered waggons by railway, as has been proposed, will not bear serious consideration. The difficulties, therefore, of realising the theoretical value of sewage are very great, and the same authorities, who estimate this at 6*s.* per head of the population, doubt whether more than 1*d.* a ton can practically be realised from its application to the soil, which is considerably under its theoretical value. Thus, taking the population of the northern area at from 1,700,000 to 1,800,000, the theoretical value of the manurial constituents of the sewage would be from 510,000 *l.* to 540,000 *l.* per annum, while the realisable, that is, in other words, the net value of 10,000,000 cubic feet per diem, at a penny a ton, would only be 422,452 *l.* 10*s.* 5*d.*, showing a loss of some 20 per cent., made up partly by actual loss, but chiefly, of course, by the cost of application. However, a penny a ton is a rough calculation, and on a great scale; with attention and careful management a rather higher average might be obtained, especially where the means are possessed of selling to farmers at critical seasons of the year, when they would be willing to pay a certain consideration for the water as well as for the manure conveyed in it. One hundred tons of sewage are sufficient, in round numbers, to cover an acre of land an inch deep, and in a dry late spring, a farmer might be disposed to pay more than 100 pence for the advantage of having an acre of meadow flooded an inch deep with even plain water. In time, therefore, this rough estimate of 1 *d.* a ton ought, with good management, to be fractionally exceeded, but this could only be hoped for in the course of years.

The Edinburgh sewage is in itself rather richer than London sewage, but as it is diluted by a natural stream of water, as the distance travelled over is not great, and as, therefore, a great portion of the solid matter remains intact, and is not mixed with the water, the liquid actually put upon the meadows is not so rich as London sewage; it is, moreover, not applied very scientifically, and there is very considerable waste. The average result, therefore, to be looked for from the systematical application of the London sewage to the Maplin Sands should be very greatly in excess of the average result obtained at Craigentinny, independently of the facts that the average temperature of the coast of Essex is considerably higher than that of Midlothian, and that the season is longer, which would ensure one additional crop. The average rental obtained for the Craigentinny Meadows is 26 *l.* or 28 *l.* per acre, but the portions which obtain the most copious and regular dressings always bring 40 *l.* per acre; and it is only reasonable to expect that ultimately the Mapiln Sands, with their greater advantages, ought to produce this higher average. This for 12,000 acres would give an annual return of 480,000 *l.*, from which would have to be deducted the Company's expenses, but not those of the farmers; and it is curious to observe how this figure is corroborated by the experiments at Rugby, from which it would appear that 100 tons of sewage are capable of producing in round numbers one ton of grass; and as the total supply of sewage is sufficient to provide 8,449 tons per acre per annum, the produce should be worth 42 *l.* per acre, or a total of 504,000 *l.* Again, say that half the sewage is applied to the Company's property, and the other half sold, at something over its value as manure merely, to the neighbouring farmers; this would give 21 *l.* per acre on the Company's property, or 252,000 *l.*, and say 5 per cent. more from the other half, or 264,600 *l.*, and a total of 516,600 *l.*

APPENDIX (B).

IT would not be safe to calculate on placing the Company's debentures at a lower rate than 5 per cent., and ½ per cent. would have to be provided to pay them off in 50 years. This would require the sum of 27,500 *l.* to be provided annually.

The rate at which we are lending money for improvements through the Lands Improvement and Land Securities Companies is at present about 6 *l.* 14*s.* per cent., which rate is sufficient to include repayment of the capital in 25 years. This, upon 240,000 *l.*, would require an annual provision of 16,080 *l.*

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PAPER put in by Mr. *Thwaites*, May 1864.

PROCEEDINGS of the METROPOLITAN BOARD of WORKS in reference to the Application of Sewage.

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THE Main Drainage Act was passed in 1858, and in 1859 the Board received two proposals for the application of sewage—one from Mr. Roberts, on behalf of the London Sewage Utilization Company; the other from Mr. Shepherd; both these were referred to the Main Drainage Committee, and as the result of their Report, the Board, on 27th January 1860, directed that advertisements should be issued, inviting tenders from persons willing to treat for the sewage of London.

The tenders were opened on 6th July 1860, and referred to the Main Drainage Committee for report.

The Report was presented 3d January 1862.

REPORT of the Committee of the Whole Board on the Main Drainage of the Metropolis:—

Spring Gardens, 1 January 1862.

YOUR Committee have to report that, in obedience to the resolutions of your Honourable Board of 6th July 1860 (No. 8) and 22d March last (No. 63), they have considered the tenders for taking the sewage of London, together with the communications addressed to the Board on the subject.

It may be convenient to describe, briefly, the more material points of the several propositions and communications which were referred to your Committee.

The Directors of the London Sewage Utilization Company propose to take so much of the sewage from the Outfall Sewer on the north side of the river as they shall require and be able to employ, for a preliminary term of two years, at a rental of 5 *l.* per annum; and on the expiration of such term, if the Company should desire it, that the Board should concede to them all such sewage conveyed by the Outfall Sewers, on both sides of the river (except the Western District Sewage), as they shall require, for a term of twenty-one years, from the expiration of the preliminary term before mentioned, at a rental of 5 *l.* per annum; that at the end of such twenty-one years, if the Company should require it, the Board shall grant them an extension of the term, at a rent or royalty to be agreed upon; and that in estimating the amount thereof, and the length of the extended term, regard shall be had in favour of the Company to the originally speculative nature of the undertaking, and to the outlay thereon. The Company also propose to reserve to themselves the right of relinquishing the sewage at any time, on giving to the Board two years' notice to that effect.

The propositions made by Mr. John James Moore embrace the taking of the whole of the sewage of the metropolis, for its application to agricultural purposes, for a term of ninety years, or other reasonable period, the Board receiving a nominal or pepper-corn rent for the first fourteen years, and at the expiration of that time one-half of the profits which may be derived from the sale of the sewage, after deducting 10 per cent. on account of the capital invested, or such reasonable return as may be awarded by arbitrators, to be appointed by Her Majesty's Secretary of State.

Mr. George Shepherd proposes, on behalf of a company to be formed, to take the sewage of London for agricultural purposes, for a term of fifty years in the first instance, the Company to be entitled, out of the revenue arising from the sale of the sewage, on all occasions, to a preference of 7½ per cent. per annum on the capital employed; that all proceeds, beyond such per-centage, shall be equally divided between them and the Board; and that, at the expiration of the fifty years, the Company shall receive a preference of 5 per cent. on their capital, the surplus being divided as before.

Mr. Charles F. Kirkman merely states that he has devised a plan for deodorising and utilising the sewage to its fullest extent, and will be prepared to submit to the Board a description of such plan, if an adequate remuneration be secured to him for it.

The propositions made by Mr. Ellis, on behalf of a company to be formed, are: That the Company shall take the sewage of London from the reservoirs at the outfalls, and raise it by pumping to elevated positions on both sides of the river, with a view to distribute it from thence for agricultural purposes—the sewage, previously to its application to the land, being freed from offensive smell, if so required by the Board; that the Board shall be empowered at any time to have the power of suspending the further distribution of the sewage, if found likely to cause a nuisance; that if, in the event of accident to the machinery, or from any other cause, the Company should be unable to apply the whole or any portion of the sewage to the land, they should be empowered to pump the same into the river, having previously deodorised and precipitated it; that from the revenue derived from the sale of the sewage, the Company shall receive a preference dividend of 5 per cent. on the amount of their paid-up capital, the remainder of the revenue being divided between them and the Board; that the management of the Company be vested in a court of directors, one-half of such directors being elected by the shareholders, the other

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other half being nominated by the Board from their own body; and that the Board shall concede the sewage to the Company in perpetuity, or for such term as they have power to grant. Mr. Ellis has furnished your Committe with additional explanations on the subject of his propositions, and has also laid before them estimates of the cost of the necessary works, the working expenses, and the anticipated revenue.

Your Committee have also had before them communications from the Honourable William Napier and Mr. Hope, V.C., on behalf of a company about to be formed for taking the dry-weather sewage of the northern area of the metropolis, from which it appears that it is contemplated to reclaim certain tracts of land on the Essex coast, to the extent of about 20,000 acres, and to render them productive by irrigating them with the sewage. The cost of the works for carrying out the plan is estimated at 2,000,000 *l.*, and it is intended to incorporate a company under an Act of Parliament, for the subscription of the capital and the working of the scheme, should the necessary grants of the land and the sewage be obtained from the Crown and this Board. The propositions made to the Board on behalf of the proposed company are as follows:—

"The grant of the sewage to be conditional on the ratification by Parliament of the grant by the Crown of the land upon which it is proposed to operate.

"The right of the company to the sewage to be absolute and exclusive for a period of 50 years, commencing from such time as may be fixed upon by the Board, and sanctioned by Parliament, for the completion of the works.

"The works of the company to be capable of taking the ordinary dry-weather discharge, as estimated by the officers of the Board, at 10,000,000 cubic feet per diem.

"All net profits realised by the company in excess of 10 per cent. on their total outlay to be equally divided between the company and the Board; such profits to be verified by the company's auditors, in conjunction with an auditor to be appointed by the Board of Trade. Should the net profits in any year, within five years after the completion of the works, not be equal to 10 per cent. on the outlay, the company to be compensated from the profits of the following years.

"In the event of the company making sales of the land, and realising more than the origina cost of their whole works, together with the stipulated 10 per cent. per annum, all profit over and above the sum thus standing at debit on the books of the company to be divided between the company and the Board. All money realised by such sales of land to go to the credit of the capital account of the company.

"On giving seven years' notice, the Board to have the right to take over, at the expiration of the grant of 50 years, the whole of the company's works and land at a valuation; such valuation in no case to be below the total original cost, as passed by the auditors above-mentioned. In the event of the Board not wishing to exercise this right, a new concession of the sewage to be granted to the company for 50 years on the same terms.

"The Board to be represented in the management of the company by two directors, who shall have all the powers of ordinary directors, with the same fees."

Your Committee have inspected a plan showing the lines of culvert to be constructed for the conveyance of the sewage to the lands to be irrigated, and have also received verbal explanations from Mr. Hope and Mr. Hemans, the engineer of the promoters, as to the nature of the scheme and the revenue expected to be derived therefrom. A more detailed description of the operations intended by the company will be found in the communications from the Honourable William Napier and Mr. Hope, which have, by direction of your committee, been already circulated amongst the members of your Honourable Board.

Your Committee, in deliberating on the various propositions, have been mainly guided by the fact that two very material points were necessary to be secured: the first, the absolute necessity for guarding the Board against the consequences which would arise in the event of a nuisance being created by the application of the sewage; and the second, the desirability of adopting, if possible, a scheme which should hold out a prospect of some benefit, in a financial point of view, ultimately accruing to the ratepayers of the metropolis. These objects are, in the opinion of your Committee, more likely to be effectually attained by the scheme propounded by the Honourable William Napier and Mr. Hope, than by either of the others which have been submitted to your Honourable Board.

The promoters of that undertaking have complied with the Standing Orders of Parliament, as to the deposit of plans, &c., and have made arrangements for prosecuting a Bill, during the coming Session, for enabling them to carry out their proposal. Your Committee have conferred with your engineer on the practicability of the scheme, and the sufficiency of the estimates for the works; and he is of opinion, after examining the detailed drawings and the estimates, that the works are well-designed, and the estimates fair and sufficient. Your Committee have also considered the draft bill prepared by the promoters. It may be proper to observe that the question whether the Board are empowered, under the provisions of their Acts, to enter into an arrangement of the nature now under consideration, is not free from doubt; but as the Bill will require modification, in order effectually to secure the interests of the Board, that point can be provided for during its passage through Parliament. Your Committee beg to submit a copy of the reports of your solicitor and engineer with reference to the scheme, and the draft bill, which reports have, by direction of your Committee, been printed, and a copy supplied to each member of your Honourable Board; and they also beg to submit a copy of the Parliamentary plans deposited by the promoters.

Your Committee, being fully impressed with the great importance of the subject intrusted to their consideration, have devoted considerable time and careful attention thereto, and have arrived at the conclusion, that it is desirable your Honourable Board should entertain favourably the proposition for dealing with the sewage of the northern area of the metropolis, contained in the communications from the Honourable William Napier and Mr. Hope, and that they should assent to the principle of a concession of the sewage of that area for a term of 50 years, provided the requisite authority be granted by the Legislature for that purpose, and subject to the introduction of all necessary clauses in the Bill, for the protection of the Board and of the public interests confided to them, and for insuring the fulfilment by the company of the obligations undertaken by them.

It is essential, in order to enable the promoters to proceed with their arrangements, and to deposit the amount required by the Standing Orders of Parliament, that your Honourable Board should, without delay, come to a decision on their propositions; and, with that view, your Committee submit their report, in order that it may be entered on the Minutes of the proceedings of the Board; and they suggest that your Honourable Board should defer the further consideration thereof until their meeting on the 10th instant; and in the meantime each member will, no doubt, avail himself of the opportunity thus afforded of possessing himself of the information contained therein.

All which your Committee beg to submit.

(signed) *J. Thwaites.*
Josiah Wilkinson.
J. S. Phillips.

On 14th February 1862 the Board's attention was called to Dr. Brady's motion for a Committee to inquire into the application of sewage to agriculture, and further consideration of report of Main Drainage Committee was adjourned until Dr. Brady's Committee should have made their report.

Dr. Brady's Committee presented their report to the House.

Board ordered further advertisement inviting tenders for sewage to be issued 6th March 1863, returnable 8th May, subsequently extended to 8th July.

METROPOLITAN BOARD OF WORKS.

The Metropolitan Board of Works hereby give notice, that on Friday, the 8th May next, they will receive tenders for the disposal of the sewage discharged by the main outfall sewers. All tenders must contain a full description of the works proposed, and must be accompanied by a plan and section showing their several details. The Board will further require full information as to the manner in which the sewage is to be treated and employed, and, if by irrigation, as to the distribution of the sewage, the quantity and locality of the land over which it is to be distributed, the points at which the sewage is to be intercepted, the daily quantity to be employed, the mode of effecting junctions or communications with the Board's sewers, the provisions against floods, failure of pumping power, or other defect in the company's works, the mode of deodorisation, or otherwise preventing the sewage from becoming a nuisance or injurious to health, the amount of capital to be invested, number and value of the shares, duration of the contract, and royalty agreed to be paid to the Board. The Board will not enter into any contract, or make any concession of sewage to any parties, unless they take all steps necessary for carrying their project into effect within a time to be named by the Board; and in the event of failure to do so, any agreement or concession on the part of the Board shall be void and of no effect; and in any contract, provision must be made to secure to the Board the return of the sewage works, and the full power to re-let and deal with the same, and so that the Board may, in case of any failure of the contractors or their operations, be left to their full rights, and without any cost to the Board. The tender must contain the names of two or more sureties, to be approved by the Board, who shall be jointly and severally bound, in a competent sum, for the due performance of the contract, and for the efficient execution of the works in accordance with the provisions and subject to the limitations of the Metropolis Local Management and Main Drainage Acts, and for indemnifying the Board against all loss, damage, or injury, claims for compensation, or legal proceedings arising out of the said works, or other operations of the contractors. The Board will not bind itself to accept the highest or any tender. The plans and sections of the sewers can be seen, and all information obtained, at the office of the Engineer of the Metropolitan Board of Works, at their office, in Spring Gardens, between the hours of nine a.m. and four p.m., or on Saturdays between nine a.m. and two p.m. The tenders are to be addressed to the Clerk of the Board, and must be delivered at this office before four o'clock on Thursday the 7th May next, and no tender will be received after that hour.

By order, (signed) *John Pollard,*
Clerk of the Board.

Board opened eight tenders, 10th July 1863, and referred them to Main Drainage Committee.

Main Drainage Committee reported on these tenders to Board, 7th August 1863.

REPORT of the Committee of the Whole Board on the Main Drainage of the Metropolis.

Spring Gardens, 29 July 1863.

Your Committee have to report that, in compliance with the resolution of your Honourable Board of 10th instant (No. 4), they have considered the several propositions for taking the sewage of the metropolis which have been made to your Honourable Board in reply to their advertisements. They find that nine communications have been received; that none fully comply with the terms of the advertisements; and that three do not make any proposals of the nature of a tender. As the subject is one which has already seriously occupied the attention of your Committee, it may be convenient to remind you that, in April 1860, you directed them to prepare a form of advertisement, in answer to which tenders were received, and opened on 6th July 1860, from Messrs. Townsend, Moore, and Shepherd, expressed in nearly the same terms as their appended communications.

The names of the parties who have replied to the recent advertisements are as follows:—

Dr. Thudichum, 2, Pembroke-road, Kensington.

Mr. David Curwood, 18, Upper Grosvenor-street.

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Lord Torrington, Sir Charles Fox, and Mr. Hunt, 8, New-street, Spring-gardens.

Mr. John James Moore, 6, Pump-court, Temple.

Mr. George Townsend, Secretary to the London Sewage Utilisation Company (Limited), 18, New-street, Spring-gardens.

Mr. George Shepherd.

Mr. C. F. Kirkman, 6, Duke-street, Adelphi.

Mr. Thomas Ellis, 76, Warwick-square, Belgravia.

The Hon. W. Napier and Mr. Hope.

Dr. Thudichum proposes, by a mechanical arrangement, so to separate the house drainage, as to retain that which he considers most valuable, and gives a sketch of his closet and drains, and tables of analyses of the constituents of fluid sewage. He estimates the cost of the works for carrying out his process at one million and a half, and the net profit at one million per annum; of this he proposes that he should receive a per centage; and that one half of the balance should be paid to the Board, and one half to the shareholders of a company to be formed for carrying out the system.

Mr. Daniel Curwood is not in a position to offer a tender, but suggests the separation of the solid and liquid sewage.

Lord Torrington, Sir C. Fox, and Mr. Thornton Hunt regret their inability to comply with the conditions of the advertisement, on the grounds of the impolicy of publicly declaring the land with which they propose to deal, but express their willingness to discuss the matter with the Main Drainage Committee, and to enter into a provisional arrangement for prosecuting a Bill in Parliament during the ensuing Session.

Of the remaining six, three refer to their previous communications, responding to the Board's advertisement in April 1860, as embodying the propositions they have to submit. These are, Mr. Moore, Mr. Townsend, on behalf of the London Sewage Utilisation Company, and Mr. G. Shepherd.

The first two are printed at length at p.p. 488, 489, of the Minutes for 1860.

The proposals of the London Sewage Utilisation Company had been previously reported on by the Main Drainage Committee, 17th January 1860.

These were, that the Board should grant the company as much sewage as they might require at Barking Creek, for two years, at a rent of 5 *l.* That, should the experiment be successful, the Board should at the end of those two years, grant a further term of 21 years, at the same rent; and at the end of such term, that the company should pay such rent for such further term, as might be agreed between the parties, or as might be determined by the arbitration of the President of the Institute of Civil Engineers, or by the Board of Trade.

The proposals of Mr. Moore were, that the Board should grant the sewage for a term of 90 years, the first 14 at a peppercorn, and at the expiration of that term, one half the profits, after deducting 10 *l.* per cent. interest on the capital invested, or on such reasonable return as the Secretary of State might award, to be paid by the grantees to the Board.

In a further communication, 9th July, 1863, Mr. Moore offers to pay one farthing per ton for every ton of sewage raised by the Board to a height of 200 feet, which at 80 million gallons daily, would, he estimates, amount to 136,000 *l.* per annum.

Mr. Moore states that he has already engagements with the occupiers of nearly 60,000 acres for the use of the sewage.

Mr. Shepherd, in answer to the Board's advertisement, adheres to the proposals made in his former letters, and states that he shall shortly be in a position to lay before the Board plans for applying the whole of the sewage; that on obtaining a concession, he will apply to Parliament for the necessary powers, and he asks for a concession of that of the south side first. Mr. Shepherd's letters extend from January 1860, to the present date, but only two communications are of the nature of tenders. The first, dated 21st April 1860, asks for a concession of the whole of the sewage of London for 50 years, and offers to divide with the Board the net profits received by the company, after paying 7½ *l.* per cent. on the invested capital; after 50 years, the company only to deduct 5 *l.* per cent. interest on their capital. The second, dated 4th July, 1860, refers to the former tender, but requests that the concession should be full and free, without let or hindrance on the part of the Board.

There remain three communications, purporting to be tenders, in answer to the Board's advertisements.

Mr. Kirkman's embodies a patent, of which he is the patentee, for obtaining manure from sewage, by filtration and deposit; the water after such treatment, to be discharged into the river. He proposes to erect works for this purpose at Barking, on condition that the Board shall convey to him the necessary land adjoining the reservoir; shall deliver the sewage to him from the main outfall sewer into his works; shall grant him the use of their river frontage and wharves for the term of seven years, at a peppercorn, seven years at a rent of one fifth the net profits, after deducting a dividend of 20 *l.* per cent. on the capital expended, and for a further term of seven years, at a rent of one-fifth the net profits, after deducting 5 *l.* per cent. on the capital, and for any further term at such rate as shall be settled by the Secretary of State. Mr. Kirkman states that he is prepared to guarantee a minimum rent of 10,000 *l.* per annum, and he undertakes to name two or more securities for the performance of the contract. He consents also to surrender the works on two years' notice, subject to the repayment of the capital invested, and of a premium of 25 *l.* per cent. thereon, and to a royalty of 1 *l.* per cent. for the use of his patent.

Mr. Ellis proposes to pump the sewage from the Board's reservoirs to certain covered tanks, constructed at such points as the Board may approve, on the banks of the Thames, from which it will be allowed to flow by gravitation through pipes laid along the sides of the roads adjoining the area to be irrigated, which is also to be approved by the Board. Mr. Ellis, on behalf of the company to be formed, undertakes to provide and use all necessary deodorising agents, and to subject himself in all things to the directions of the Board; he further offers to submit the Act of Incorporation for the Board's approval. The net profits, deducting working and management expenses and reserve fund, he proposes to divide equally between the company and the Board; and he suggests that three of the directors should be nominated by the Board. The concession of the sewage he requires should be in perpetuity, subject to the Board's power to purchase after 50 years, on giving three years' notice; the price to be fixed by valuers, chosen jointly. Messrs. Payne, Eddison, and Ford undertake to pay 60,000 *l.* to the credit of Mr. Ellis' local trustees, on his obtaining the concession of the sewage on satisfactory terms.

Messrs. Napier and Hope propose to intercept the whole of the ordinary flow of the northern sewage, near Abbey Mills, and to convey it by a culvert, 44 miles in length, to Maplin Sands, on the one hand, and Dengie Flats, on the other. Both these areas are at present submerged at high water, and their redemption is part of the project, extending to 15 or 20 thousand acres. The capital proposed to be invested is two millions; the concession of the sewage to be for 50 years, subject to Parliamentary authority being obtained, and to a grant of the land from the Crown. The net profits to be divided equally between the Company and the Board, after a deduction of 10 per cent. on the outlay. The Board to have the power of resuming the grant of sewage, and taking the whole of the land and works at a valuation, at the end of the term of 50 years, on giving seven years' notice; or a new concession to be granted, on terms to be settled by the Secretary of State. The Board to be represented by two directors of the Company. The Company to be formed within two years after obtaining Parliamentary powers. The Company, within three months of its formation, to pay into the hands of trustees, chosen jointly, a sum of 25,000 *l.* India 5 per cent. stock, interest to be paid to the Company until three-fourths of the works are complete; the whole to be forfeited to the Board if the Company abandon the enterprise before three-fourths are completed.

Your Committee have thought it desirable, for the information of your Honourable Board, to append to this Report the several tenders which have been from time to time made to the Board, for taking the sewage of the Metropolis, together with supplementary documents and explanation of such tenders; and your Committee have also included in the Appendix other communications, which have been addressed to your Honourable Board on the question of the sewage.

All which your Committee beg to submit.

(signed) *J. Thwaites.*
Robt. Freeman.
William Tite.
J. Pew.
W. H. Dalton.
Chas. Harris.
P. H. Le Breton.
Philip Crellin.
G. B. Richardson.
Silas Taylor.
F. Healey.
Edw. Shepherd.
E. C. Dermer.
William Carpmael.
J. S. Phillips.
Wm. H. Lammin.
Fred. Doulton.

Special Meeting of Board to consider Report of Main Drainage Committee, 1st December 1863.

Resolved,—"That, inasmuch as the Board are bound by various provisions of the several enactments under which their works are carried on, so to conduct them as not to cause a nuisance, and as the profitable employment of sewage, under the schemes proposed in the tenders, may involve its application to the surface of the land on an extensive scale, the Board cannot be parties to any agreement for such application unless they have clear information as to locality, nature, and extent of the land to be so dealt with, and satisfactory assurance that the processes to be employed are such as will not cause a nuisance; that none of the tenders received are sufficiently clear on this latter point; the Board, therefore, refer them generally to the Main Drainage Committee, in order to obtain essential and detailed information, and to confer with the several parties as to other conditions named in the advertisements, upon which their proposals are neither full nor explicit, and generally to consider as to the utilisation of sewage."

The Main Drainage Committee, in accordance with the reference, met on 16th and 23d February and 8th March last, and heard evidence from the several parties, and have ordered the same to be printed, for the private information of the members of the Board.

Appendix, No. 20.

App. No. 20.

THE UTILISATION OF SEWAGE.

LETTER to Lord *Robert Montague* and the Members of the Select Committee appointed by the House of Commons in the Year 1864, to inquire into any Plans for dealing with the Sewage of the Metropolis, and other large Towns, with a View to its Utilisation to Agricultural purposes; By Lord *Torrington*, Sir *Charles Fox*, *Thornton Hunt*, and *Richard Smith.*

My Lords and Gentlemen, London, 25 May 1864.

KNOWING the great difficulties which have to be encountered in treating the important questions connected with the utilisation of the metropolitan sewage, and in forming a correct opinion upon the whole of the subject, we venture to present a few remarks as to some of the principal points. In the first place, we note the necessity of obtaining reliable data, upon which to base calculations as to the practicability of utilising the sewage with advantage to the ratepayers; but, the health of the inhabitants, and economy in the constituents of their food are the two points of the most vital importance.

Mr. Bazalgette, Mr. Mechi, and Captain Galton, reckon the total amount of sewage draining the metropolitan district annually, as follows:—

	Tons, Gross Sewage.
By Mr. Bazalgette - - - - -	268,667,090
By Mr. Mechi - - - - - -	303,000,750
By Captain Galton - - - - -	328,884,990

It will be observed that these calculations vary materially. Another element of uncertainty, that would considerably affect them, is to be found in the rainfall. The total for the year is usually taken at 25 inches, but in 1863, the total was actually returned at 20 inches; and the distribution within the year is still more uncertain, as may be seen by the monthly return for the year 1863, viz.:—

	Inches.		*Inches.*
January - - -	2.6	August - - -	1.8
February - - -	0.6	September - -	3.2
March - - -	0.7	October - - -	1.7
April - - -	0.4	November - -	1 8
May - - -	1.3	December - -	1.1
June - - -	3.9		
July - - -	0.9	Total - -	20 inches.

In a paper read before the Society of Civil Engineers on the 31st January 1857, Mr. Bazalgette showed that in 1855 there were 226 dry days, and 139 wet days; and we calculate that on those 139 days the distribution would probably stand thus:

		Inches.
90	days on which the rainfall varied from the smallest portion to one-tenth of an inch - - - - - - -	4 ½
21	days, varying from one-tenth to one-fifth of an inch -	6 ½
28	days, on which there were heavy rains - - - - -	13
139	days. Total (apart from the 226 days) - -	24 Inches.

It would appear from this statement, that more than half the rain falls in 28 days, and any plan that does not provide for disposing of half an inch of rainfall would still leave fully one half the general rainfall to pollute the Thames. A plan marked by that deficiency would render useless all attempts to purify the river; for half an inch of rainfall in 28 days is more than four times the quantity of the sewage.

It is somewhat difficult to render these calculations intelligible without further detail, and we therefore hope to be excused if we enter into the matter at greater length.

As to the gross annual amount of the sewage proper, it may be stated that Mr. Bazalgette, Captain Galton, and Dr. Franklin give the following figures:—

	Tons.
Mr. Bazalgette - - - - - - -	155,544,750
Captain Galton - - - - - -	215,762,650
Dr. Franklin - - - - - - -	132,393,895

The London area is given as follows:

Mr. Mechi - - - - - - -	144 square miles.
Mr. Thwaites - - - - - - -	117½ „
Mr. Bazalgette - - - - - - -	103 „

Notwithstanding these statements, which undoubtedly claim the attention due to the position of the several authorities, we have the most reliable calculations, which justify us in stating, that exclusive of the Wandle, Ravensbourn, and one or two other comparatively pure streams, the area of the Metropolitan district does not exceed 70 square miles, or 44,800 acres.

Dr. Franklin gives the total of the sewage at 81,250,000 gallons per diem, and taking the rainfall at half an inch, less one-third abstracted by evaporation, we have the following net results:—

	Tons.
Rainfall (½ inch per day) - - - - - -	1,493,334
Sewage (81,250,000 gallons) - - - -	362,723
Total (per day) - -	1,856,057 Tons.

To provide for this aggregate there will be required,—

No of Mains.	*Diameter.*	*Tons.*
7 - - - - - - -	3 ft. 6 in. =	705,369
4 - - - - - - -	4 ft. 6 in. =	678,856
Northern outfall reservoir - - - - - -		226,290
Southern „ „ - - - - -		131,871
No. 5 pumping stations - - - - -		131,701
	Total (per day) - -	1,874,087 Tons,

leaving in reserve a balance of 18,030 tons.

The amount of sewage indicated above is equal to 132,393,895 tons per annum, and the rainfall to 74,666,667 tons, making a total of 207,060,562 tons.

To lift these aggregate amounts of sewage and rainfall, in order to the proper distribution, we shall require a maximum of 19,096 horse-power in 28 engines, that number however allowing a reserve of three engines.

The cost in coals, manual labour, oil, &c., will be about one-eighth of a penny per ton. The sewage proper would not cost more than one-twelfth of a penny per ton, requiring 4,702 horse-power to lift it 180 feet; or 13 engines of 376 horse power, and also seven mains, three feet in diameter, to distribute it. With these figures the cost will be as follows, viz.:—

	£.
13 engines, 4,702 horse power - - - - - - - -	94,040
126,720 tons of main pipe - - - - - - - -	443,520
281,600 yards, excavating and laying same - - - - -	140,800
1,309 miles or 2,303,840 yards lineal of earthenware distributing pipes, average 12 inches diameter, laid and jointed - - -	460,768
Improvements and drainage on 153,589 acres - - - - -	1,305,506
Stock and implements - - - - - - - -	1,075,123
Artificial filter beds (1,000 acres) - - - - - -	50,000
TOTAL - - - £.	3,569,757

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On the whole area, this calculation will give 862 tons of sewage per acre per annum.

On the 70 square miles or 44,800 acres (but still excluding the rivers Wandle, Ravensbourn, and other unpolluted streams, the removal of the sewage, together with the half inch of rainfall will cost as follows :—

	£.
Improvements, drainage, &c., on 240,000 acres - - -	2,125,000
Stock and implements ,, - - - - - -	1,680,000
280,228 tons of mains ,, - - - - -	980,798
760,320 yards, excavating and laying same - - - -	380,160
1,760 miles or 3,097,600 yards lineal of earthenware distributing pipes, average 12 inches diameter - - - - -	619,520
28 black engines of 19,096 horse power - - - - -	263,200
Artificial filter beds, 1,000 acres - - - - - -	50,000
TOTAL - - - £.	6,098,678

This will give 862 tons of sewage per acre per annum on the area.

Half an inch of rainfall will require 18,560 acres to apply 100 tons per acre.

The Value of Sewage.

The sewage is usually reckoned to be worth one penny per ton, but should the farmer be charged that price, he would probably begin to look round his own premises to see how he could manufacture the commodity for himself, and would then find that he has within his own control a cheaper article.

We may state that Baron Liebig gives the London sewage in its present state, on Professor Ways' analysis, at one penny and a third per ton. We would also direct attention to the circumstances associated with the Bill before your Honourable House, in reference to the Edinburgh and Leith sewage. One of the objects of that bill is to convey the sewage to the sea, the inhabitants not being satisfied with the plan of distributing it near the town.

Deodorisation of the Sewage.

We consider that all sewage, both in a sanitary and an agricultural point of view, ought to be deodorised; and if the London sewage were to be deodorised and passed through vegetating filter beds, it would purify both the river and the atmosphere. It is only to vegetation that we can look for the purification of our polluted waters and the atmosphere.

There are further observations which we think it desirable to offer, and they will be printed and forwarded to your Honourable Committee. In the meantime, the foregoing details may, perhaps, be regarded as of service in dealing with the important question under consideration.

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PAPER handed in by Mr. *Brunlees*, 23 May 1864.

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EXTRACT from further Particulars given to the Main Drainage Committee of the Metropolitan Board of Works, in 1859.

Gentlemen,

IN reply to your inquiry, I beg to hand you the following explanation of the details of my scheme for utilising the sewage.

The amount of liquid which can be spread over a given surface, and filtered in a given space of time through a previously determined thickness of material, must always depend on the nature of that material, be it gravel, sand, or clay, and on the density of the liquid to be filtered and its temperature.

Thus in the case of the soil of England we often find three or four different sorts of earth within a very small area; hence the calculations applicable to one field might require to be essentially varied for the field next adjoining.

Again, at certain seasons of the year, nay even at various periods of the day, the liquid with which we shall afterwards have to deal varies in its consistency and fertilising powers, so that experience alone can point out to us the best methods of dealing with such a material.

This experience we hope to gain in our experiment on about 1,000 acres of meadow land.

I propose, therefore, for the present, to give only such a general outline of the plan we intend to adopt as may lead your Board to see that we have carefully considered the various details of sewage irrigation, and that we are prepared to deal with this subject in a business-like and efficient manner.

In applying the liquid sewage to irrigation by means of iron mains, with branches to the various panes or plots of grass, we expect to be able to avoid all the objections in a sanitary point of view that have been made to a system of open irrigation.

The liquid sewage from which the brickbats and other extraneous objects have been strained by means of a grating, is conveyed by the pipes to the highest point in each plot of ground, it is there emptied into gutters which, when full, overflow the land.

As no ground could be formed, without enormous expense, with a prescribed fall, so as to permit the sewage to irrigate successively each portion of the plot, contour gutters will be formed, following the natural inclination of the land. These in their turn will be filled with what has run off the ground from the ground of a higher level, and, when full, will overflow on to that surface which has not been previously irrigated.

By these means we shall prevent the sewage escaping into the ditches, without having previously filtered through a surface of earth. The land being divided like the squares on a chessboard, on the completion of the irrigation of one plot the next is proceeded with, and so on, until the quantity of land under cultivation has all been once watered; the irrigation of the first lot will then be recommenced.

When a large quantity of land is under cultivation, then several plots dispersed over the surface will be irrigated at one time.

Your Committee will remember that when asked what quantity of sewage I thought it might be possible to place, in the course of a year, on an acre of ground, I replied that I was led to believe that, under certain circumstances, we might be able to employ such a quantity as would be equivalent to a depth of nine feet over the surface of the land.

It will readily suggest itself to your Board that where we may fail in creating, or do not find naturally, an effective drainage, it will be impossible to filter through a depth of three or four feet of earth so considerable a body of liquid as above contemplated, about once a month. I did not explain fully to your Committee that it was my intention to irrigate each plot of ground once a month between March and October, and twice a month during November, December, January, and February—16 applications—during each of which about 6¾ inches would be allowed to soak into the ground.

You also requested me to furnish you with the details of calculations showing how I had arrived at the conclusion, that, if it should eventually be found practicable to employ sewage equal to a depth of nine feet over each acre of land, 9,000 acres would then suffice for the quantity of sewage produced on the completion of your works within the area drained into your main outfall channel at Barking Creek.

The maximum flow of intercepted rain-fall allowed for in the construction of the sewer on the combined area of the high, middle and lower level sewers—say, 24,449 acres—is equal to 79 inches per annum, which gives a total of 13,339 cubic feet per minute, or 7,011,239,730 cubic feet per annum.

Vide Mr. Bazalgette's Report, May 1856, sec. 2, after page 26.

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It is a well-known fact that the annual average rainfall over the metropolis is 24 inches, and that about 15 inches pass off by evaporation: hence we have only to provide irrigation works for nine inches per annum,

	Total Rain.
Or	798,748,830
The maximum flow of sewage during 310 working days	3,186,403,200
Sundays and holidays—say, one-fourth of working days	141,321,400
During one year	3,327,724,600
From this must be deducted the 25 per cent. allowed for contemplated increase of population	831,931,150
Total sewage without rainfall	2,495,793,450

	Cubic feet per annum.
Intercepted rain	798,748,830
Sewage	2,495,793,450
Rain and sewage together	3,294,542,280

$$\frac{3{,}294{,}542{,}280}{43{,}560 \times 9 = 392{,}040}$$ square feet in one acre, = 8,403 acres, nine feet deep.

As a practical test for the correctness of these calculations, we may instance the case of Edinburgh, where the sewage of a population of 80,000 irrigates 325 acres of meadows. If we apply the same proportion to the land that may be irrigated near Barking Creek, we find that 8,361 acres will suffice.

Should, however, the actual yield of sewage exceed this calculation, and be capable of irrigating a larger area than above provided for, the promoters would derive greater advantages by extending the area of their operations.

I think Mr. Bazalgette will bear me out in the statement that he will find little difficulty in furnishing us during the two years' experiment with an increasing quantity of sewage, in proportion to the quantity we can employ over the 1,000 acres.

The total quantity of land proposed to be taken is divided on the plan into three tracts, coloured respectively blue, green, and red.

The blue portion, having an extent of 1,700 acres, is more favourably situated for irrigating operations than the green or red, on account of its proximity to the mains of the Metropolitan Board of Works.

The estimated capital and annual expenses are as follows:—

	£.	s.	d.
CAPITAL to be expended in irrigation and drainage works in the blue portion*	20,090	–	–
ANNUAL OUTLAY:			
Interest on capital 20,090 *l.*, at 7½ per cent. per annum	1,506	15	–
Rent of land, 1,700 acres, at 7 *l.* per acre	11,900	–	–
Working expenses, 1,700 acres, at 1 *l.* per acre	1,700	–	–
£.	15,106	15	–

The land, coloured green, represents an area of 4,400 acres. It lies to the east of Barking Creek, which has to be syphoned under, and will be irrigatedby gravitation, in the same manner as the land coloured blue.

The estimated capital and annual outlay are as follows:—

	£.	s.	d.
CAPITAL required for irrigation and drainage	100,538	–	–
ANNUAL OUTLAY:			
Interest on works, 100,538 *l.*, at 7½ per cent. per annum	7,540	7	–
Rent of land, 4,400 acres, at 7 *l.* per acre	30,800	–	–
Working expenses, 4,400 acres, at 1 *l.* per acre	4,400	–	–
£.	42,740	7	–

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* This is an outlay on permanent plant of 11 *l.* 16 *s.* 4¼ *d.* per acre. It is probable that hereafter a further sum may be required for roadways.

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The land coloured red on the plan lies at too great an elevation to admit of its being irrigated by gravitation; the outlay of capital is in consequence somewhat greater.

	£.	s.	d.
CAPITAL to be expended in irrigation and drainage works	60,960	–	–

	£.	s.	d.
ANNUAL OUTLAY:			
Interest on works, 60,960 *l.*, at 7½ per cent. per annum	4,572	–	–
Rent, 2,300 acres, at 7 *l.* per acre*	16,100	–	–
Working expenses, at 1 *l.* per acre	2,300	–	–
Pumping power	2,454	–	–
£.	25,426	–	–

The total capital required will be as follows:—

	£.	s.	d.
Land coloured blue	20,090	–	–
Ditto green	100,538	–	–
Ditto red	60,960	–	–
£.	181,588	–	–

The total annual outlay will be as follows:—

	£.	s.	d.
Land coloured blue	15,106	15	–
Ditto green	42,740	–	–
Ditto red	25,426	–	–
£.	83,272	15	–

From information procured at Craigentinny Farm it appears the actual amount received in the year 1858 averaged 27 *l.* 2 *s.* per imperial acre on the land irrigated by gravitation, viz.:—

	£.	s.	d.
35 acres, let at from 35 *l.* to 40 *l.*, or 37 *l.* 10 *s.* =	1,312	–	–
30 " " 30 *l.* " 35 *l.* " 32 *l.* 10 *s.* =	975	–	–
65 " " 25 *l.* " 30 *l.* " 27 *l.* 10 *s.* =	1,787	–	–
120 " " 20 *l.* " 25 *l.* " 22 *l.* 10 *s.* =	2,700	–	–
£.	6,775	–	–

Total rental	£. 6,775	=	Average.
Total acreage	250		£. 27. 2 *s.*

5, Victoria-street, Westminster,
10 August 1859.

Dear Sir,

I HAVE recently heard it stated that the Metropolitan Board of Works are about to invite tenders for the construction of their main from Deptford to Crossness Point, together with reservoirs, engines, pumps, and deodorising works.

If you should find this report well grounded, I think you ought at once to wait upon the Board, and ask them to defer letting the reservoir and other deodorising works until your experimental irrigation scheme has been tried; for should this prove successful (and I have little doubt about it if we can arrange for the land), and you should eventually deal with the whole of the metropolitan sewage, then you would effect a great saving to the Board, and confer a lasting boon on agriculture.

Instead

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* The greater portion of this land is reported to be now let at 35*s.* and 50*s.* per acre. It is generally sandy, with an excellent substratum, and is admirably adapted for sewage irrigation.

App. No. 21.

Instead of all the first and annual cost of deodorising works, the Board would have only to make a storm overflow at Crossness Point, and lead the mains forward to the east side of the town of Erith, where, according to our recent survey, the first suitable land for irrigation is met with.

It is hardly necessary for me to state that the works we should require would cost a mere fraction of the proposed deodorising works.

While on this subject it may be as well to refer to two or three matters connected with the irrigation scheme on the north side of the river. I understood from you some time ago that the Board were waiting for a report from the chemists before they finally completed their arrangements with you. I need hardly say that these delays have complicated our arrangements, and if the Board intend to give you the sewage they ought to do so at once, so that we may be enabled to make the most advantageous arrangements.

If the principle of sewage utilisation had been well established, time would not be so great an object; but I crave time for reflection on every step we take. May I therefore ask you to urge the Board to a decision? I do not, however, wish you to have a decision at all, unless it be on such fair terms as will enable you to carry a work of great responsibility to a successful commercial issue; and the plain straightforward way of proving this would be for the Board to urge on the construction of the main from the River Lea to Barking Creek, so that they might deliver by next autumn as much sewage as would irrigate the land coloured blue, and thus begin to test the experiment. Before the High Middle and Low Level Sewers could be completed, the practicability of using the whole of the sewage would be decided, and hence, from the point on the marsh marked D on the plan to Barking Creek, the Board would only have to construct a storm-overflow. There would be no difficulty in having our experimental works quite ready by next autumn.

From a recent careful survey of the marshes east of Barking Creek, we find that the application of sewage will be of little avail unless the general drainage of the land be lowered, and this can only be accomplished by deepening the sluice outlets into the Thames. Taking this fact along with the difficulties under which we labour from the Board having semi-officially announced our project lately in "The Times" paper, I do not see my way to progress without an Act of Parliament. There would, however, be this advantage to the Board, that if you obtain power they would be relieved from all responsibility; and with the aid of the Board, coupled with the influence you can bring to bear on this important matter, there ought to be little difficulty in obtaining the sanction of the Legislature.

Taking these matters into account, and the probability of the sewage from the Western District being also conveyed to Barking Creek—which will considerably augment the cost of pumping, and altogether materially increase the outlay beyond our previous estimates—I have no doubt that if you represent all those matters to the Board, they cannot reasonably object to convey the sewage to such points as may hereafter be mutually arranged with the Engineer.

In conclusion I beg to state that, from having given the subject of utilising the London sewage very full and careful consideration, I am quite prepared to meet the Engineer to the Board of Works, and to explain to him the whole of our intended operations.

I am, &c.
(signed) *James Brunlees.*

C. H. Roberts, Esq

Appendix, No. 22.

METROPOLITAN BOARD OF WORKS.

RETURN of the TENDERS for the MAIN DRAINAGE WORKS, showing the Names of the Persons who put in those Tenders, and the Amounts of the Tenders, and also the Names of the Sureties Proposed.

Name of Work.	Names of the Parties Tendering, and Amounts of Tenders.				Names of Sureties Proposed.
		£.	s.	d.	
Northern High Level Sewer.	Messrs. M'Lennan & Bird, Osnaburgh-street.	181,370	–	–	Mr. John Watling, Pimlico; and Mr. Samuel Tildesley, 2, Irongate Wharf, Paddington.
	Mr. John Wilson, Suffolk-street - - -	266,725	–	–	Proposes to deposit securities of the value of 25,000 *l.*
	Messrs. Crook & Son, Coleman-street, City, and Hackney.	259,858	–	–	The Bank of England.
	Mr. George Myers, Lambeth - - -	238,760	–	–	George Smeed, Sittingbourne, Kent; and Mr. Armani, Basinghall-street.
	Mr. Joseph Diggle, Laureston, Dover - -	185,000	–	–	William Diggle, Heywood, and Handringe, near Rochdale; and James Diggle, Boston Spa, near Tadcaster, Yorkshire.
	Mr. W. Webb, Albion-road, Stoke Newington.	202,888	–	–	Frederick Charles Wilkins, Great Winchester-street, City; and Richard Webb, Highwood Hendon, Middlesex.
	Messrs. Dethick & Thirst, 77, Great Cambridge-street, Hackney-road, and John-street, Chelsea.	186,000	–	–	Richard Davis, 37, St. James-square, Notting Hill; and William Addis, Leicester-street, Leicester-square.
	Mr. John Jay, City Basin - - - -	234,130	–	–	William Lee, lime merchant, Upper Ground-street, Blackfriars; and David Montague, cement merchant, Bankside.
	Mr. Webster Arlsey, Baldock, Herts - -	169,090	–	–	Meaburn Staniland, solicitor, Boston, Lincolnshire; and George Hackford, Boston, merchant.
	Mr. William Hill, Whitechapel-road - -	186,875	–	–	John Joseph Hickmott, merchant, Mile End; and James Stiff, Lambeth.
	Mr. Moxon, Cannon-street, City, and Dover, Kent.	152,430	–	–	William Northern, stoneware manufacturer, Lambeth, London; and Henry Millichamp, Lambeth, London.
	Mr. R. Batterbury, Fitzroy-road - - -	191,000	–	–	William Rowe, 5, Clifton Villas; and Thomas Thomas, 101, Stanhope-street.
	Messrs. Wood, Epping-place, Mile End -	195,680	–	–	Orlando Attwell, London terrace Hackney-road; and John Patten, Mile End-road.
	Mr. W. H. Rowe, Gloucester-place, Gloucester-crescent.	180,433	–	–	William Rowe, 5, Clifton-road, Camden-square; and Mortimore Timpson, Stanhope-place, Mornington-crescent.
	Mr. S. P. Hocken, Pownall-road, Dalston -	270,200	–	–	Mr. Norton, Wharf-road, City-road; and Mr. Millichamp, Princes-street, Lambeth.
	Messrs. J. & E. Bird, Hammersmith - -	189,399	–	–	William Landon, Inver Villa, New-road, Hammersmith; and James Bird, Phœnix Cottage, Brook Green, Hammersmith.
Northern Outfall Sewer	Messrs. William Hill & Co., 203, Whitechapel-road.	649,666	–	–	John Joseph Hickmott, Mile End; James Stiff, Lambeth; and George Axton, Notting Hill.
	Mr. George Furness, 36, Great George-street.	625,000	–	–	James Furniss, Great Longstone, Derbyshire; and James Firbank, Newport, South Wales.
	Mr. Thomas Brassey, 4, Great George-street	661,245	–	–	Messrs. Dixon and Wardell, Chester.
	Mr. William Webster, Charlton Wharf, Woolwich.	690,000	–	–	M. Staniland, esq., Boston, M. P.; and George Hackford, Boston, merchant.
	Mr. Joseph Diggle, 1, Castle-terrace, Dover	660,000	–	–	William Diggle, "The Standrings," near Rochdale; and James Diggle, Belle Vue, Clifford, near Tadcaster, Yorkshire.
	Messrs. George Boulton & Co., Wakefield -	666,666	–	–	John Butler, Stunningly Iron Works, Leeds; and Isaac Briggs, Londal Cliffe, Wakefield.
	Mr. Edward Thirst, John-street, Chelsea -	650,000	–	–	William Addis, Leicester-street, Soho; and Richard Shelton, Halsey-street, Chelsea.
	Mr. W. Dethick, 77, Great Cambridge-street, Hackney-road.	646,000	–	–	Richard Davis, 37, St. James-square, Bayswater; and Thomas Dowcra, Ballspond-road, Islington.
	Mr. W. Moxon, 25, Parliament-street - -	642,000	–	–	Henry Millichamp, London; and William Northern, London.
	Mr. G. Todd, jun., Ranelagh Works, Cheyne-walk, Chelsea.	699,500	–	–	John Sellors Bonsall, Matlock, Derbyshire.
Northern Outfall Sewer (Fencing).	Messrs. R. & J. Rankin, Union Foundry, Liverpool.	3,740	–	–	John Henderson, Chatham-street, Liverpool; and George Holme, Percy-street, Liverpool.
	The Isca Foundry Company, Newport, Monmouth (Informal).	at 10 *l.* per ton			Persons with whom the Board shall be satisfied.
	Messrs. Hernulewicz & Co., 3, Delahay-street, Westminster.	3,304	15	–	Arthur Warner, Threadneedle-street, London; and B. M'Mahon, Dublin.
	Messrs. Jukes, Coulson, & Co., 11 & 12, Clements-lane, City.	2,519	10	–	John Dickinson, 25, Clements-lane, E. C.; and Thomas G. Hastings, 28, Clements-lane, E. C.
	Mr. M. S. Shaw, 64, Cannon-street, City -	3,180	–	–	D. Baldwin, Contractor, 46, Acacia-road, St. John's-wood; and James English, 23, Budge-row, City.
	Mr. W. Dethick, 77, Great Cambridge-street, Hackney-road.	4,274	–	–	Richard Davis, esq., 37, St. James-square, Notting Hill; and William Bowles, esq., Craven Hall-lodge, Bayswater.
	The St. Pancras Iron Works Company, Old St. Pancras-road.	2,866	15	–	Mr. W. S. Burton, 39, Oxford-street; and Mr. S. Marshall, Jeffrey-street, Camden Town.
	Messrs. Jones & Blaxton, 80, Goswell-street, St. Luke's.	5,149	–	–	Mr. Thomas Usher, iron merchant, Pump-row, Old Street-road, E. C.; and Mr. William Elliott, engineer, &c., Mount Mills, Seward-street, E. C.
	Messrs. J. B. Brown & Co., 18, Cannon-street, City.	2,585	–	–	Robert King, esq., 58, Pall Mall; and John Logan Muir, esq., 28, Basinghall-street.

RETURN of the TENDERS for the Main Drainage Works, showing the Names of the Persons who put in Tenders, &c.—*continued.*

Name of Work.	Names of the Parties Tendering, and Amounts of Tenders.				Names of Sureties Proposed.
		£.	s.	d.	
Northern Outfall Sewer (Fencing)—*continued.*	Messrs. W. Simpson & Co., Isle of Dogs -	4,160	–	–	Charles Simpson, M.D., 9, Sussex-street, Warwick-square; and David Simpson, 29, Hatton Garden
	Messrs. Hill & Smith, Brierley Hill Iron Works, near Dudley.	2,627	10	–	William Barrow, esq., Straits House, near Dudley; and Mr. Edward Webb Springfield, Wordsley, near Stourbridge.
	Messrs. Baylis, Simpson, & Jones, 4, Broad-street Buildings, City.	2,535	10	–	H. R. Clark, esq., 38 and 39, Cow Cross-street, West Smithfield, E. C.; and Thomas Hampton, esq., the firm of Hampton & Co., ironmasters, Bilston, Staffordshire.
	Messrs. R. Garrett & Sons, Leiston Works, Saxmundham, Suffolk (including 20 gates and posts).	2,686	–	–	Mr. Abraham Garrett, Camden Brewery, Hawley-crescent, N.W.; and Mr. George Grimwood, of same place.
	Messrs. Cottam & Co., 2, Winsley-street, Oxford-street.	4,161	–	–	Messrs. Robinson & Cottam, the Statue Foundry, Pimlico; and Mr. W. S. Burton, 39, Oxford-street.
	Mr. J. Horton, junior, Brierley Hill - -	2,422	–	–	Thomas Horton, Smethwick, near Birmingham; and Charles Robinson, Brierley Hill.
	Messrs. Ransomes & Sims, Orwell Works, Ipswich.	2,735	–	–	William Swain, metal merchant, 14, Pinner's Hall, Old Broad-street, London; and Arthur Cole, Lower Brook-street, Ipswich.
	Messrs. C. D. Young & Co., 19, Great George-street, Westminster.	2,690	–	–	George Fletcher, esq., Brunswick Works, Wolverhampton; and George Cupples, esq., Edinburgh.
	Messrs. Thomas Perry & Son, Highfields Works, Bilston.	2,678	12	–	Mr. F. R. Wheeldon, Wolverhampton, and Mr. James Smith of Wolverhampton.
	Messrs. Hawks, Crawshay, & Sons, Gateshead Iron Works, Gateshead-upon-Tyne.	4,070	–	–	No sureties.
	Messrs. John Rogerson & Co., 2, Royal Exchange Buildings.	3,276	–	–	Messrs. H. I. Morton & Co., Leeds; and Mr. I. T. Begbie, 4, Mansion House-place, E. C.
	The Horseley Company, Tipton, Staffordshire	3,600	–	–	Mr. Henry Rogers, 43, Upper Thames-street; and Mr. William Demprey, 26, Great George-street, Westminster.
	Messrs. Drury & Biggleston, Canterbury -	3,200	–	–	Mr. George Lancefield, Canterbury, builder; and Mr. Thomas Brine, of Canterbury, linendraper.
	Mr. David Davies, 55, Collingwood-street, and Bear-lane Iron Works, Blackfriars-road.	3,873	10	–	Mr. James Blackman, of 180, Blackfriars-road; and Mr. James H. Harris, 72, Broadwall, Blackfriars-road.
	Mr. F. W. Gerish, 16, East-road, City-road -	3,500	–	–	John Masham, of North-place, Kingsland; and Joshua Whaley, 14, East-road, City-road.
	Messrs. George John Calvert & Co., Railway Foundry, York.	2,497	–	–	Francis William Calvert, esq., York, Registrar of City Court of Record; and Francis Calvert, esq., York, gentleman.
Middle Level Sewer, North.	Mr. William Henry Rowe, 7, Gloucester-place, Gloucester-crescent.	264,533	–	–	Mr. William Rowe, of 59, Camden-road Villas, N. W.; Mr. Mortimore Timpson, of Stanhope-place, Mornington-crescent, N. W.; Mr. Thomas Thomas, 101, Stanhope-street, N. W.; and Mr. John Birch, of Edward-street, Regent's Park. N. W.
	Mr. William Moxon, 25, Parliament-street -	322,575	–	–	Mr. H. Millichamp, of London, and Mr. W. Northern, of London.
	Mr. William Webster, Asylum Works, Arlsey, Baldock.	325,000	–	–	Meaburn Staniland, esq., M.P., of Boston; and Herbert Ingram, esq., M.P., Rickmansworth, Herts.
	Mr. William Lavers, 40, Sutton-street, Belvedere-road.	328,500	–	–	T. Howard Lavers, esq., Blackheath, Kent; and J. Payne, esq., Milton-street, Dorset-square.
	Mr. Edward Thirst, John-street, Chelsea -	329,000	–	–	William Addis, Leicester-street, Soho; and Richard Shelton, of Halsey-street, Chelsea.
	Mr. William Hill, 203, Whitechapel-road.	333,000	–	–	John Joseph Hickmott, of Mile End; and Mr. John Perry, of Cambridge Heath.
	Mr. William Dethick, 77, Great Cambridge-street, Hackney-road.	337,000	–	–	Richard Davis, esq. 37, St. James square, Notting Hill; and William Bowles, esq., Craven Lodge, Craven Hill, Bayswater.
	Messrs. Newton & Fletcher, 5 Montpelier-road, Rye-lane, Peckham.	347,452	–	–	Edward Price, Belle Vue House, Highgate; and Edward Jackson, of New Cross, Surrey.
First taken by Mr. W. H. Rowe, who failed. Afterwards re-advertised, and taken by Messrs. Brassey & Co.	Messrs. Thomas Brassey & Co., 4, Great George-street, Westminster.	329,800	–	–	Messrs. Dixon & Wardell, Chester.
	Mr. William Dethick, 77, Great Cambridge-street, Hackney-road.	335,000	–		Richard Davis, esq., 37, St. James-square, Notting Hill; and Mr. Thomas Dowcra, Ballspond-road, Islington.
	Mr. Edward Thirst, John-street, Chelsea -	345,000	–	–	William Addis, of Leicester-street, Soho; and Richard Shelton, of Halsey-street, Chelsea.
	Mr. William Webster, Woolwich - -	350,000	–	–	Stephen Lever, esq., Boston; and George Hackford, Boston, merchant.
	Mr. William Hill, 203, Whitechapel-road -	357,200	–	–	Mr. John Joseph Hickmott, of Mile End, and G. Axton, of Shepherd's Bush.
	Mr. Josh Diggle, 1, Castle-terrace, Dover -	363,000	–	–	William Diggle, "The Standrings," Lancashire; and James Diggle, of Boston Spa, Yorkshire.
	Mr. Rowland Brotherhood, Chippenham, Wilts.	346,500	–	–	John Ravenhill, esq., of Warminster, Wilts; and Gabriel Goldney, esq., of Chippenham, Wilts.
	Mr. J. Millichamp, for Mr. W. Moxon, Dover.	322,575	–	–	Henry Millichamp, London, and W. Northern, London.
Ranelagh Storm Overflow.	Mr. Francis Rummins, 40, Mecklenburgh-square, London.	35,800	–	–	George Holme, Liverpool; Joseph Pitts, Stunningley, Yorkshire.
	Mr. John Newton, Montpelier-road, Peckham	29,493	–	–	George Furness, esq., 36, Great George-street; John Fletcher, esq., Horbourn, near Birmingham.
	Mr. W. Moxon, 25, Parliament-street - -	27,600	–	–	William Northern, London; H. Millichamp, London.
	Mr. W. Dethick, 77, Great Cambridge-street, Hackney-road.	23,500	–	–	Richard Davis, esq., 37, St. James-square, Notting Hill; William Bowles, esq., Craven Hall-lodge, Bayswater.
	Mr. R. Robinson, Oakland Villa, Shepherd's Bush.	24,963	–	–	Mr. G. Axton, Norland-road, Shepherd's Bush; Mr. Sisson, Hull, Yorkshire.
	Mr. William Hill, 203, Whitechapel-road -	25,926	–	–	John Joseph Hickmott, Mile End-road; George Axton, Shepherd's Bush.
	Mr. Richard Batterbury, 9, Fitzroy-road, Camden Town.	26,500	–	–	Mr. William Row, 5, Clifton Villas; Mr. Thomas Thomas, 101, Stanhope-street.
	Mr. Edward Thirst, John-street, Chelsea -	24,927	–	–	William Addis, Leicester-street, Soho; Richard Shelton, Halsey-street, Chelsea.

RETURN of the Tenders for the Main Drainage Works, showing the Names of the Persons who put in Tenders, &c.—*continued.*

Name of Work.	Names of the Parties Tendering and Amounts of Tenders.				Names of Sureties Proposed.
		£.	s.	d.	
Ranelagh Storm Overflow—*continued.*	Mr. William Lavers, 40, Sutton-street, Lambeth.	26,317	–	–	John Payne, esq., Milton-street, Dorset-square; T. H. Lavers, Blackheath.
	Mr. William H. Rowe, 7, Gloucester-place, Gloucester-crescent.	29,689	–	–	Mr. William Rowe, 59, Camden-road Villas, N. W.; Mr. John Birch, Edward-street, Regent's Park, N. W.
	Messrs. John and Edward Bird, Hammersmith.	26,779	–	–	Mr. James Bird, Phœnix Lodge, Brook Green; Mr. William Bird, Blomfield Villa, Shepherd's Bush.
	Mr. John Aird, Belvedere-road, Lambeth -	30,765	–	–	James M. Rosseter, esq., Sumner-street, Southwark, S. E.; Joseph Quick, esq., Dartmouth Villas, Lewisham road, S. E.
	Mr. William Tredwell, 15, Parliament-street	35,435	–	–	Mr. George Wythes, Reigate; Mr. Alfred N. Bean, Shooter's Hill, Kent.
Ranelagh Storm Overflow (Underpinning).	Mr. William Dethick - - - - -	2,996	–	–	Mr. Richard Davis; Mr. William Bowles.
Acton Branch, Western Sewers.	Messrs. Walker and Neave, 141, Southwark Bridge-road.	8,850	–	–	Mr. James Stiff, High-street, Lambeth; Mr. Frederick Shadbolt, Thornhill Wharf, Caledonian-road.
	Mr. R. Robinson, Oakland Villa, Shepherd's Bush.	9,454	–	–	Mr. G. Axton, brick merchant, Norland-market, Shepherd's Bush; William Sisson, Hull, builder and contractor.
	Mr. George Axton, 41, Norland-road, Notting Hill.	9,351	10	–	M. Peter Broad, Oaklands, Shepherd's Bush; Mr. William Hill, 203, Whitechapel-road.
	Messrs. James and Samuel Williams, Clifton-street, Notting Hill.	10,200	–	–	Mr. Samuel Tildesley, Irongate Wharf, Paddington, brick and stone merchant; Mr. James Walton, 25, Clements-lane, City.
	Mr. William Hill, 203, Whitechapel-road -	10,129	–	–	John Joseph Hickmott, Mile End; Mr. John Perry, of Cambridge Heath.
	Mr. Joseph Yeoman, 2, Grafton-place, Kentish Town.	10,157	–	–	Mr. James Barrenger, Hampstead-road; Mr. John Culverhouse, Camden-town Wharf.
	Mr. William H. Rowe, 7, Gloucester-place, Gloucester-crescent.	10,640	–	–	Mr. William Rowe, 5, Clifton-road, Camden-square, N. W.; Mr. Mortimore Timpson, Stanhope-place, Mornington-crescent.
	Messrs. John and Edward Bird, Hammersmith.	9,945	–	–	William Landon, esq., Inva Villa, Hammersmith; James Bird, esq., Brook Green.
	Mr. W. Dethick, 77, Great Cambridge-street, Hackney-road.	10,500	–	–	Richard Davis, esq., 37, St. James-square, Notting Hill; William Bowles, esq., Craven Hall-lodge, Craven-hill, Bayswater.
	Mr. Edward Thirst, John-street, Chelsea -	9,890	–	–	William Addis, Leicester-street, Soho; Richard Shelton, Halsey-street, Chelsea.
Southern High Level Sewer.	Messrs. William Dethick and E. Thirst, 77, Great Cambridge-street, Hackney-road, and John-street, Chelsea.	223,000	–	–	Richard Davis, esq., 37, St. James's-square, Notting Hill; William Addis, esq., Leicester-street, Leicester-square.
	Mr. Wiliam Lavers, Belvedere-road, Lambeth.	229,000	–	–	Mr. T. H. Lavers, Blackheath, Kent; Mr. J. Payne, Milton-street, Dorset-sqnare.
	Mr. William Moxon, 25, Parliament-street -	217.800	–	–	H. Millichamp, London; W. Northern, London.
	Mr. William Downes, 10, Union-street, Southwark.	228,760	–	–	Mr. Robert Downes, Grosvenor Villa, Camberwell; Mr. Joseph Bolton, Thornhill-road, Islington.
	Mr. Thomas Lucas, 2, Clarendon-terrace, Camberwell New-road.	217,000	–	–	William Moxon, of London and Dover, contractor; William Northern, 14, Vauxhall-walk, Lambeth.
	Mr. William H. Rowe, 7, Gloucester-place, Gloucester-crescent.	218,600	–	–	Mr. Mortimore Timpson, Stanhope-place, Mornington-crescent, N. W.; Mr. William Rowe, 5, Clifton-road, Camden-square, N. W.; Mr. John Birch, Edward-street, Regent's Park; and Mr. Joseph Rickett, Hampstead.
	Messrs. J. N. Hilling & Co., Streatham -	217,000	–	–	Mr. William Lee, Upper Ground-street, lime merchant; Joseph Ivimey, Ampthill-square.
	Mr. William Webster, Asylum Works, Arlesey, Baldock, Herts.	216,750	–	–	Herbert Ingram, esq., M. P., Rickmansworth Hall, Herts; J. W. Staniland, esq., M. P., Boston, Lincolnshire.
	Mr. George Myers, Lambeth - - -	242,700	–	–	George Smeed, esq., Sittingbourne, Kent; A. Armain, jun., London.
	Mr. Thomas Pearson, 1, Bilby-place, Vauxhall.	18,087	–	–	James Stiff, of Lambeth; and William Northern, of London.
	Mr. Edward Thirst, John street, Chelsea -	23,000	–	–	Mr. William Addis, Leicester-street, Soho; and Richard Shelton, Halsey-street, Chelsea
	Mr. Wm. Dethick, 77, Great Cambridge-street, Hackney-road.	23,305	–	–	Richard Davis, esq., 37, St. James-square, Notting Hill; and Mr. Thomas Dowcra, Ballspond-road, Islington.
	Mr. John Walker, 141, Southwark Bridge-road.	23,130	–	–	Mr. James Stiff, High-street, Lambeth; and Mr Frederick Shadbolt, of Thornhill Wharf, Caledonian-road.
	Mr. John W. Sawyer, Dulwich, and 10, Cannon-street, City.	31,000	–	–	Mr. Alderman Sawyer, 108, Queen's-road, Brighton; and Mr. George David Sawyer, merchant, 110, North-street, Brighton.
	Messrs. Hill, Keddell, and Robinson, 203, Whitechapel-road.	21,100	–	–	George Axton, esq., Shepherd's Bush; and Mr. John Joseph Hickmott, Mile End-road.
	Mr. William Downes, 10, Union-street, Southwark.	19,643	–	–	Robert Downs, esq., Grosvenor Villa, Camberwell; and Richard Downs, esq., Camden-place, Camberwell.
	Mr. William Webster, Charlton Wharf, Woolwich.	20,400	–	–	M. Staniland, Esq., M. P., Boston, and Harrington Hall, Lincolnshire; and Mr. George Smeed, Sittingbourne, Kent.
	Mr. James Marriott, Coventry - - -	18,800	–	–	Alfred Dawson Lea, esq., solicitor, Coventry; and Abraham Burbury, esq., Cowndon, near Coventry.
	Messrs. Henry Geddes & Co., 13, President-street, Goswell-road.	20,429	1	10	John Pinder, C. E., Hanover-street, Pimlico, and 6, Doddington-grove, Newington; and John Duckworth, esq., Oak Cottage, Ulverston, and Spellow-lane, Kirkdale, near Liverpool.
Southern Outfall Sewer	Mr. Edward Thirst, John-street, Chelsea -	373,000	–	–	William Addis, Leicester-street, Soho; and Richard Shelton, of Halsey-street, Chelsea.
	Messrs. Brassey & Ogilvie, 4, Great George-street, Westminster.	331,000	–	–	Messrs Dixon & Wardell, bankers, Chester.
	Mr. Wm. Dethick, 77, Great Cambridge-street, Hackney-road.	330,000	–	–	Richard Davis, esq., 37, St. James's-square, Kensington; W. Bowles, esq., Craven Hill, Bayswater.
	Mr. William Hill 203, Whitechapel-road -	328,000	–	–	John Joseph Hickmott, Mile End-road; and George Axton, of Shepherd's Bush.

RETURN of the Tenders for the Main Drainage Works, showing the Names of the Persons who put in Tenders, &c.—*continued.*

Name of Work.	Names of the Parties Tendering, and Amounts of Tenders.	£.	s.	d.	Names of Sureties Proposed.
Southern Outfall Sewer —*continued.*	Messrs. Newton and Fletcher, 5, Montpelier-road, Peckham.	316,059	19	8	Edward Price, esq., Belle Vue House, Highgate, N.; and E. W. Jackson, esq., Loompitt Hill, New Cross, S. E.
	Mr. William Lavers, 40, Sutton-street, Belvedere-road.	305,500	–	–	Jonathan Payne, esq., Wilton-street, Dorset-square; and Thomas Howard Lavers, esq., of Lewisham, Kent.
	Mr. William Moxon, 25, Parliament-street.	303,890	–	–	William Northern, London, and H. Millichamp, London.
	Mr. Fuller Coker, Ware, Herts - - -	301,582	–	–	Mr. George Burge, 22, Queen-square, Bloomsbury; and William G. Ree, of Ware, Hertfordshire.
	Mr. William Webster, Arlsey, near Baldock, Herts.	300,000	–	–	Meaburn Staniland, esq., M.P., Boston, Lincolnshire; and H. Ingram, esq., M.P., of Rickmansworth, Herts.
	Mr. Joshua Diggle, Dover - - - -	(informal)			None.
Deptford Pumping Station.	Mr. George Myers, Lambeth - - -	124,765	18	3	George Smeed, esq., Sittingbourne, Kent; and A. Armani, esq., London.
	Mr. William Webster, Charlton Wharf, Woolwich.	113,900	–	–	M. Staniland, esq., M.P., Boston, and Mr. George Smeed of Sittingbourne.
	Mr. Edward Thirst, John-street, Chelsea -	155,371	–	–	William Addis, Leicester-street, Soho; and Richard Shelton, of Halsey-street, Chelsea.
	Mr. Randal Stap, 32, King William-street -	104,285	–	–	Agrees to leave in the hands of the Metropolitan Board of Works a percentage off each instalment until such amounts to 10,000 *l.*; and reference made to the Government authorities at Woolwich, and to Messrs. Holroyd & Norton, of Laurence Poultney-hill, Cannon-street, E. C.
	Messrs. J. Aird & Son, Belvedere-road, Lambeth.	113,136	–	–	J. M. Rosseter, esq., Cleveland-gardens, Hyde Park; and Joseph Quick, esq., Denmark-hill, Camberwell.
	Mr. William Hill, 203, Whitechapel-road -	151,049	–	–	Joseph John Hickmott, Mile End-road, and James Stiff, Lambeth.
Deptford Pumping Engines.	Messrs. Sandys, Vivian, & Co., Hayle, Cornwall.	51,000	–	–	No Sureties.
	Williams Perran Foundry Company, Perranar-Worthal, Cornwall.	47,050	–	–	
	Messrs. Harvey & Co., Hayle, Cornwall, and 12, Haymarket, London.	47,000	–	–	
	Messrs. Rothwell & Co., Union Foundry, Bolton.	44,350	–	–	
	Messrs. James Watt & Co., 18, London-street, City.	34,850	–	–	
	Messrs. Martin, Samuelson, & Co., Hull -	31,655	–	–	
	Messrs. Benjamin Hick & Son, Bolton-le-Moors.	29,945	–	–	
	Messrs. R. & W. Hawthorn, Newcastle-upon-Tyne.	29,500	–	–	
	Messrs. Slaughter & Co., Avonside Iron Works, Bristol.	22,300	–	–	
Earl Outlet - -	Mr. John Aird, Belvedere-road, Lambeth -	8,566	–	–	Joseph Quick, esq., 1 Dartmouth Villas, Lewisham-road, Greenwich; Alexander Fraser, esq., Grand Junction Water Company, Campden-hill, Kensington.
	Mr. Matthew Jenning, 2, Albert-road, Nunhead, Peckham.	11,189	11	–	Mr. John Newton, Montpelier-road, Rye-lane, Peckham; Mr. Greenhill, 13, Parliament-street, Westminster.
	Mr. William Lavers, 40, Sutton-street, Belvedere-road.	10,458	–	–	J. Payne, esq., 8, Milton-street, Dorset-square; W. R. Parker, Esq., Carlton-road, Worksop.
	Mr. William Dethick, 77, Great Cambridge-street, Hackney-road.	10,875	–	–	Richard Davis, esq., 37, St. James-square, Notting Hill; William Bowles, esq., Craven Hall-lodge, Bayswater.
	Mr. William Hill, 203, Whitechapel-road.	9,421	–	–	J. J. Hickmott, Mile End-road; George Axton, Shepherd's Bush.
	Mr. Edward Thirst, John-street, Chelsea -	10,960	–	–	William Addis, Leicester-street, Soho; Richard Shelton, Halsey-street, Chelsea.
Portion of Southern Low Level Sewer.	Mr. John Aird - - - - - -	9,150	–	–	None.
	Mr. John Ward, Borstal House, Rochester, Kent	278,400	–	–	Theophilus Smith, esq., Sittingbourne, Kent; and John George Aress, esq., Sittingbourne, Kent.
	Messrs. Myers & Sons, Lambeth - -	297,986	–	–	Anthony Armani, esq., 6, Guildhall Chambers, Basinghall-street, City; and George Smeed, esq., Sittingbourne, Kent.
	Messrs. Brassey, Ogilvie, & Harrison, 4, Great George-street.	327,000	–	–	Messrs. Dixon & Wardell, Chester.
	Messrs. Hill, Keddell, & Robinson, 203, Whitechapel-road.	333,000	–	–	John Joseph Hickmott, esq., Mile End-road, and George Acton, esq., Shepherd's Bush.
	Messrs. John Aird & Son, Belvedere-road -	323,136	–	–	James Marmaduke Rosseter, esq., Cleveland-gardens, Hyde Park; and Joseph Quick, esq., Sumner-street, Southwark.
	Mr. William Webster, Burham Wharf, Belvedere-road, Lambeth.	300,000	–	–	M. Staniland, esq., M.P., Reform Club, and of Boston; and George Smeed, esq., Sittingbourne, Kent.
	Messrs. Edward Thirst & Co., John-street, Chelsea.	315,000	–	–	William Addis, esq., Leicester-street, Leicester-square, and Richard Shelton, esq., Halsey-street, Chelsea.
	Mr. William Lavers, Sutton-street, Lambeth	309,000	–	–	Thomas Howard Lavers, esq., Lee, Kent; and William R. Parker, esq., Carlton, Notts.
	Mr. George Furness, 36, Great George-street, Westminster.	320,000	–	–	Messrs. John and James Furness, Great Longstone, Derbyshire; and Mr. A. P. Burt, Charlotte-row, Mansion House.
	Messrs. Peto & Betts, 9, Great George-street, Westminster.	330,825	–	–	Undertake to provide responsible Sureties.

Return of the Tenders for the Main Drainage Works, showing the Names of the Persons who put in Tenders, &c.—*continued.*

Name of Work.	Names of the Parties Tendering, and Amounts of Tenders.				Names of Sureties Proposed.
		£.	s.	d.	
Southern Outfall Works (Engines, Pumps, &c.)	Messrs. Harvey & Co., Hayle, Cornwall -	59,500	–	–	Messrs. Williams, Perran Foundry Company, Perran-ar-Worthal, Cornwall; and Messrs. Sandys, Vivian, & Co., Hayle, Cornwall.
	Messrs. Hick & Son, Bolton - - -	49,320	–	–	Agree to provide Sureties.
	Messrs. Sandys, Vivian, & Co., Hayle, Cornwall.	59,000	–	–	Harvey & Co., Hale Foundry, Cornwall; and Williams' Perran Foundry Company, Perranar-Worthal, Cornwall.
	Messrs. R. & W. Hawthorn, Newcastle-on-Tyne.	41,500	–	–	Messrs. Rayne & Burn, iron merchants, Newcastle-upon-Tyne; and Mr. George Brown, ironfounder, Newcastle-on-Tyne.
	Messrs. James Watt & Co., 18, London-street, City.	44,900	–	–	None.
	Messrs. Martin, Samuelson, & Co., Hull -	51,000	–	–	None.
	Messrs. Slaughter, Gruning, & Co., Bristol -	50,600	–	–	Messrs. Vivian & Sons, of London and Swansea; and Mr. Samuel T. Cooper, of Leeds Iron Works, Leeds.
	Williams' Perran Foundry Company, Perran-ar-Worthal, Cornwall.	60,000	–	–	Messrs. Sandys, Vivian, & Co., Hayle, Cornwall; and Messrs. Harvey & Co., Hayle Foundry, Cornwall.
Bermondsey Branch -	Messrs. Peto & Betts, 9, Great George-street, Westminster.	97,523	–	–	Undertake to provide responsible Sureties.
	Mr. William Downs, 28, Union-street, Southwark.	119,430	–	–	Robert Downs, esq., Grosvenor Villa, Camberwell; and Richard Downs, esq., Camden-place, Camberwell.
	Messrs. John Aird & Son, Belvedere-road, Lambeth.	107,000	–	–	James Marmaduke Rosseter, esq., Cleveland-gardens, Hyde Park; and Joseph Quick, esq., Denmark-hill, Camberwell.
	Mr. William Webster, Burham Wharf, Belvedere-road, Lambeth.	119,500	–	–	M. Staniland, esq., M.P., Boston, Lincolnshire; and George Smeed, esq., Sittingbourne, Kent.
	Mr. W. Dethick, 77, Great Cambridge-street, Hackney-road.	126,077	–	–	Richard Davis, esq., 37, St. James-square, Bayswater, and Mr. Thomes Dowcra, builder, Ballspond-road, Islington.
	Mr. W. Lavers, Sutton-street, Belvedere-road, Lambeth.	124,000	–	–	T. H. Lavers, esq., Lee, Kent; and Mr. H. Millichamp, Princes-street, Lambeth.
	Messrs. W. Moxon & Co., Dover - -	99,875	–	–	W. Northern, esq., London, and J. B. Briggs, esq., Dover.
Western Sewers - -	Messrs. Ritson & Ridley, 20, Great George-street, Westminster.	65,000	–	–	Mr. George Wythes, contractor, Reigate; Mr. William Warden, ironmaster, Birmingham.
	Mr. James Marriott, Coventry - - -	57,000	–	–	Mr. A. D. Lea, solicitor, Coventry; Mr. A. B. Herbert, gentleman, Condon, near Coventry.
	Mr. William Dethick, 77, Great Cambridge-street, Hackney-road.	63,861	–	–	Richard Davis, esq., 37, St. James'-square, Bayswater; Mr. Thomas Dowcra, builder, &c., Ballspond-road, Islington.
	Mr. E. Thirst, John-street, Chelsea - -	57,900	–	–	Mr. William Addis, ironmonger, Leicester-street, Leicester-square; Mr. Richard Shelton, Halsey-street, Chelsea.
	Mr. Joseph Diggle, 1, Castle-terrace, Dover -	66,708	–	–	William Diggle, esq., "The Standrings," near Rochdale; Mr. James Diggle, Boston Spa, Yorkshire.
	Messrs. Hill, Keddell, and Robinson, 203, Whitechapel-road.	60,890	–	–	John Hickmott, Mile End road; George Axton, Shepherd's Bush.
	Messrs. W. Moxon & Co., Dover - -	56,740	–	–	William Northern, Lambeth, London; J. B. Briggs, esq., Dover.
	Mr. John W. Sawyer, 10, Cannon-street, City.	59,927	–	–	Mr. George David Sawyer, Brighton, merchant; Mr. William H. Simms, 9, Thurloe-place, South Kensington, gentleman.
Southern Low Level Sewer.	Messrs. Waring Brothers, 5, Victoria-street, Westminster.	283,518	–	–	John Waring, Haworth Hall, near Rotherham; Alfred Davis, Blandford, Dorset.
	Mr. George Furness, 36, Great George-street, Westminster.	350,000	–	–	Sir Joseph Paxton, M.P., Rockhills, Sydenham, Kent; William Jackson, esq., M.P., Manor House, Birkenhead.
	Mr. Joseph Diggle, 1, Castle-terrace, Dover	261,000	–	–	William Diggle, esq., "The Standrings," Bagslate, Rochdale, Lancaster; James Diggle, esq., Clifford, near Boston Spa, Yorkshire.
	Mr. William Lavers, 40, Sutton-street, Lambeth.	237,500	–	–	T. H. Lavers, esq., Lee, Kent; R. W. Parker, esq., Carlton, Notts.
	Mr. William Dethick, 77, Great Cambridge-street, Hackney-road.	270,000	–	–	Richard Davis, esq., 37, St. James-square, Notting Hill; Mr. Thomas Dowcra, Ballspond-road, Islington.
	Mr. William Webster, Burham-wharf, Belvedere-road, Lambeth.	234,000	–	–	M. Staniland, esq., M.P., Boston, and Harrington Hall; George Smeed, esq., Sittingbourne, Kent.
	Mr. Samuel C. Ridley, 20, Great George-street.	215,000	–	–	Mr. George Wythes, Reigate, Surrey; Mr. John Tredwell, Streatham, Surrey.
	Messrs. Hill, Keddell, & Robinson, 203, Whitechapel-road.	240,000	–	–	John Joseph Hickmott, Mile End-road; George Axton, Shepherd's Bush.
	Mr. William Harding, Clyde House, Lee, Kent.	263,400	–	–	Frederick Robert Gilder, of Church-court, Clements-lane, City, merchant; Charles Joseph Carttar, Katherine House, Greenwich, Kent, gentleman.
	Messrs. Brassey, Ogilvie, and Harrison, 4, Great George-street.	325,000	–	–	Thomas Dixon, esq., banker, Chester; William Wardell, esq., banker, Chester.
	Messrs. W. Moxon & Co., London and Dover.	282,000	–	–	Thomas Briggs, esq., Dover; William Northern, esq., London.
	Messrs. John Aird & Son, Belvedere-road -	279,393	–	–	James M. Rosseter, esq., Cleveland-gardens, Hyde Park; Joseph Quick, esq., Denmark-hill, Camberwell.
Northern Outfall Reservoir.	Mr. John Jay, Metropolitan Railway, King's-cross.	218,467	–	–	Mr. Charles Cave Williams, Goswell-street Railway Carriage Works; Mr. David Montague, Bankside, cement merchant.
	Mr. Samuel C. Ridley, 20, Great George-street, Westminster.	184,400	–	–	Mr. George Wythes, Reigate; Mr. William M. Warden, ironmaster, Birmingham.
	Messrs. George Myers & Sons, Lambeth -	194,069	–	–	George Smeed, esq., brickmaker, Sittingbourne, Kent; Anthony Armani, esq., Guildhall-chambers, Basinghall-street, City.
	Mr. Stephen Lewin, Custom House Quay, Boston.	191,400	–	–	Henry Dresser, esq., merchant, 14, Great St. Helens, London; Francis Millus, esq., gentleman, Poole, Dorsetshire.
	Messrs. W. Dethick & Co., Great Cambridge-street, Hackney-road.	177,000	–	–	Richard Davis, esq., 37, St. James-square, Bayswater; N. Lindo, esq., 47, Moorgate-street, City.
	Messrs. W. Moxon & Co., London and Dover.	164,000	–	–	T. Briggs, esq., Dover; W. Northern, esq., London.

RETURN of the Tenders for the Main Drainage Works, showing the Names of the Persons who put in Tenders, &c.—*continued.*

Name of Work.	Names of the Parties Tendering, and Amounts of Tenders.				Names of Sureties Proposed..
		£.	s.	d.	
Northern Outfall Reservoir—*continued.*	Messrs. Brassey, Ogilvie, & Harrison, 4, Great George-street, Westminster.	190,000	–	–	Messrs. Dixon & Wardell, of Chester.
	Mr. Thomas Dowcra, Ballspond road	156,575	–	–	Mr. James Hunter, Engineer, &c., Bow, Middlesex; J. Venn, esq., 2, Paper-buildings, Temple, solicitor.
	Messrs. Perry & Judson, Broadway, Stratford.	194,363	–	–	Messrs. Collins & Stanbury, ironmongers, Bread-street, Birmingham; Mr. Samuel Trickett, stone merchant, Isle of Dogs, Poplar.
	Messrs. Hill, Keddell, & Robinson, 203, Whitechapel-road.	167,907	–	–	John Joseph Hickmott, Mile End-road; George Axton, Shepherd's Bush.
	Mr. Joseph Diggle, 1, Castle-terrace, Dover.	169,900	–	–	William Diggle, esq, gentleman, "The Standrings," Bagslate, near Rochdale; James Diggle, esq., gentleman, Clifford, near Tadcaster, Yorkshire.
	Mr. William Harding, Clyde House, Lee, Kent.	174,000	–	–	R. F. Gilder, of Church-court, Clements-lane, London, merchant; Charles J. Carttar, Greenwich, Kent, gentleman.
	Mr. George Furness, 36, Great George-street, Westminster.	164,000	–	–	Sir Joseph Paxton, Rockhills, Sydenham; William Jackson, esq., M.P., Manor House, Birkenhead.
	Messrs. Eckersley & Bayliss, 25, Parliament-street, Westminster.	131,000	–	–	William M'Cormick, esq., M.P., London; Peter Eckersley, esq., Manchester.
Western Sewers (Extension).	Mr. William Moxon - - - - -	Under the basis of Schedule of Prices.			Mr. William Northern, Vauxhall-walk, Lambeth; and Mr. Thomas B. W. Briggs, Caple Lodge, near Folkestone.
Greenwich Sewers -	Mr. Josh. F. Meston, 7, Fortess-terrace, West, Kentish Town.	17,285	–	–	Mr. Henry Ellis, Deptford, and Mr. W. Northern, Vauxhall.
	Mr. William Dethick, 77, Great Cambridge-street, Hackney-road.	22,940	–	–	Richard Davis, of 9, Theresa-terrace West, Hammersmith; and Nathaniel Lindo, 47 A, Moorgate-street, City.
	Mr. Thomas Pearson, Kennington-cross -	27,450	–	–	Mr. James Stiff, High-street, Lambeth; and G. Smeed, esq., Sittingbourne, Kent.
	Mr. William Lavers, Sutton-street, Belvedere-road, Lambeth.	28,300	–	–	T. H. Lavers, esq., and John Payne, esq., Milton-street, Dorset-square.
	Messrs. W. Moxon & Co., Fulham - -	29,372	–	–	William Northern, Vauxhall-walk, and Thomas B. Briggs, Caple Lodge, near Folkestone.
	Messrs. John Aird & Son, Belvedere-road, Lambeth.	29,530	–	–	James Marmaduke Rosseter, esq., Cleveland-gardens, Hyde Park; and Joseph Quick, esq., Denmark-hill, Camberwell.
	Mr. E. Thirst, John-street, Chelsea - -	31,400	–	–	Mr. William Addis, Leicester-street, Leicester-square; and Mr. Richard Shelton, of Halsey-street, Chelsea.
	Messrs Hill & Keddell, 203, Whitechapel-road.	32,300	–	–	J. J. Hickmott, Mile End Road, and George Axton, Shepherd's-bush.
	Mr. William Webster, Lee Grove, Lee, Kent	35,000	–	–	M. Staniland, esq., M.P., of Boston; and George Smeed, esq., Sittingbourne.
Northern Low Level Sewer.	Mr. William Webster, Wyberton Villa, Lee, Blackheath.	229,000	–	–	Meaburn Stainland, esq, M.P., Boston; and Thomas Parry, esq., Sleaford.
	Mr. W. Dethick, 77, Great Cambridge-street, Hackney-road.	233,000	–	–	Richard Davis, esq., 9, Theresa-terrace West, Hammersmith; and Nathaniel Lindo, esq., 47A, Moorgate-street, City.
	Messrs. W. Moxon & Co., Fulham Park, Fulham.	247,840	–	–	E. dé Pass, of 9, Fenchurch-street, City; and Charles W. Hutton, of 6, Newgate-street, City.
	Messrs. Thomas Brassey & Co., 4, Great George-street.	258,000	–	–	Thomas Dixon, esq., of Chester, banker; and George Wythes, esq., of London, contractor.
	Mr. George Furness, 36, Great George-street	259,000	–	–	E. Clench, of Manor House, Clapham; and W. Cleland, of 2, Waterloo-place, Pall Mall.
	Mr. Thomas Pearson, Kennington-cross -	265,500	–	–	James Stiff, esq., High-street, Lambeth; and George Smeed, esq., of Sittingbourne, Kent.
	Mr. A. W. Ritson, 24, Norfolk-street, Strand	337,499	–	–	Such gentlemen as shall meet the approval of the Honourable the Metropolitan Board of Works.
	Messrs. Thorne & Co., Cremorne Wharf, Chelsea.	309,746	–	–	Thomas Dakin, esq., 2, Sydney-place, Lewisham-road; and Lionel Jackson Noah, of Messrs. Jacksons, Nephews, & Co., 12, Fenchurch-street.

Spring Gardens,
30 June 1864.

John Pollard,
Clerk.

Appendix No. 23.

LIST of all the TENDERS for the MAIN DRAINAGE WORKS, including the LOW LEVEL SEWER, showing the Name, the Amount for which each Tender was accepted, and the Names of the Sureties.

NAME of WORK.	NAMES OF PARTIES TENDERING.				Tender Accepted, showing Amount.	Names of Sureties.
		£.	s.	d.		
Northern High Level Sewer.	Messrs. M'Lennan and Bird, Osnaburgh-street	181,370	–			
	Mr. John Willson, Suffolk-street	266,725	–	–		
	Messrs. Crook and Son, Coleman-street, City, and Hackney.	259,858	–	–		
	Mr. George Myers, Lambeth	238,760	–	–		
	Mr. Joseph Diggle, Laureston, Dover	185,000	–	–		
	Mr. W. Webb, Albion-road, Stoke Newington	202,888	–	–		
	Messrs. Dethick and Thirst, 77, Great Cambridge-street, Hackney-road; and John-street, Chelsea.	186,000	–	–		
	Mr. John Jay, City Basin	234,130	–	–		
	Mr. Webster, Arlsey, Baldock, Herts	169,090	–	–		
	Mr. William Hill, Whitechapel-road	186,875	–	–		
	Mr. Moxon, Cannon-street, City; and Dover, Kent	152,430	–	–	Mr. William Moxon, 152,430 *l.*	Mr. William Northen, Mr. Henry Millichamp, and Mr. Matthew Turner Shaw.
	Mr. R. Batterbury, Fitzroy-road	191,000	–	–		
	Messrs. Wood, Epping-place, Mile End	195,680	–	–		
	Mr. W. H. Rowe, Gloucester-place, Gloucester-crescent.	180,433	–	–		
	Mr. S. P. Hocken, Pownall-road, Dalston	270,200	–	–		
	Messrs. J. and E. Bird, Hammersmith	189,399	–	–		
Northern Outfall Sewer.	Messrs. William Hill and Co., 203, Whitechapel-road.	649,666	–	–		
	Mr. George Furness, 36, Great George-street	625,000	–	–	Mr. G. Furness, 625,000 *l.*	Sir Joseph Paxton, Knt., M.P Wm. Jackson, M.P.
	Mr. Thomas Brassey, 4, Great George-street	661,245	–	–		
	Mr. William Webster, Charlton Wharf, Woolwich	690,000	–	–		
	Mr. Joseph Diggle, 1, Castle-terrace, Dover	660,000	–	–		
	Messrs. George Boulton and Co., Wakefield	666,666	–	–		
	Mr. Edward Thirst, John-street, Chelsea	650,000	–	–		
	Mr. W. Dethick, 77, Great Cambridge-street, Hackney-road.	646,000	–	–		
	Mr. W. Moxon, 25, Parliament-street	642,000	–	–		
	Mr. G. Todd, jun., Ranelagh Works, Cheyne-walk, Chelsea.	699,500	–	–		
Northern Outfall Sewer (Fencing).	Messrs. R. and J. Rankin, Union Foundry, Liverpool.	3,740	–	–		
	The Isca Foundry Company, Newport, Monmouth, (Informal).	at 10 *l.* per ton.				
	Messrs. Hernulewicz and Company, 3, Delahay-street, Westminster.	3,304	15	–		
	Messrs. Jukes, Coulson and Company, 11 and 12, Clement's-lane, City.	2,519	10	–		
	Mr. M. S. Shaw, 64, Cannon-street, City	3,180	–	–		
	Mr. W. Dethick, 77, Great Cambridge-street, Hackney-road.	4,274	–	–		
	The St. Pancras Iron Works Company, Old St. Pancras-road.	2,866	15	–		
	Messrs. Jones and Blaxton, 80, Goswell-street, St. Luke's.	5,149	–	–		
	Messrs. J. B. Brown and Company, 18, Cannon-street, City.	2,585	–	–		
	Messrs. W. Simpson and Company, Isle of Dogs	4,160	–	–		
	Messrs. Hill and Smith, Brierley Hill Iron Works, near Dudley.	2,627	10	–		
	Messrs. Baylis, Simpson, and Jones, 4, Broad-street Buildings, City.	2,535	10	–		
	Messrs. R. Garrett and Sons, Leiston Works, Saxmundham, Suffolk (including 20 gates and posts).	2,686	–	–		
	Messrs. Cottam and Company, 2, Winsley-street, Oxford-street.	4,161	–	–		
	Mr. J. Horton, jun., Brierley-hill	2,422	–	–	Mr. J. Horton, jun., 2,422 *l.*	No sureties.
	Messrs. Ransomes and Sims, Orwell Works, Ipswich	2,735	–	–		
	Messrs. C. D. Young and Company, 19, Great George-street, Westminster.	2,690	–	–		
	Messrs. Thomas Perry and Son, Highfields Works, Bilston.	2,678	12	–		
	Messrs. Hawks, Crawshay and Sons, Gateshead Iron Works, Gateshead-upon-Tyne.	4,070	–	–		
	Messrs. John Rogerson and Company, 2, Royal Exchange Buildings.	3,276	–	–		
	The Horseley Company, Tipton, Staffordshire	3,600	–	–		
	Messrs. Drury and Biggleston, Canterbury	3,200	–	–		
	Mr. David Davies, 55, Collingwood-street; and Bear-lane Iron Works, Blackfriars road.	3,873	–	–		
	Mr. F. W. Gerish, 16, East-road, City-road	3,500	–	–		
	Messrs. Geo. John Calvert and Company, Railway Foundry, York.	2,497	–	–		

NAME of WORK.	NAMES OF PARTIES TENDERING.	£.	s.	d.	Tender Accepted, showing Amount	Names of Sureties.
Middle Level Sewer North.	Mr. William Henry Rowe, 7, Gloucester-place, Gloucester-crescent.	264,533	–	–	Mr. W. H. Rowe, 264,583 *l.*	Mr. Wm. Rowe. Mr. Mortimore Timpson. Mr. John Birch. Mr. Thomas Thomas.
	Mr. William Moxon, 25, Parliament-street	322,575	–	–		
	Mr. William Webster, Asylum Works, Arlsey, Baldock.	325,000	–	–		
	Mr. William Lavers, 40, Sutton-st., Belvedere-road	328,500	–	–		
	Mr. Edward Thirst, John-street, Chelsea	329,000	–	–		
	Mr. William Hill, 203, Whitechapel-road	333,000	–	–		
	Mr. William Dethick, 77, Great Cambridge-street, Hackney-road.	337,000	–	–		
	Messrs. Newton and Fletcher, 5, Montpelier-road, Rye-lane, Peckham.	347,452	–	–		
	Messrs. Thomas Brassey and Co., 4, Great George-street, Westminster.	* 329,800	–	–	Messrs. Brassey & Co. 329,800 *l.*	Mr. Thomas Dixon. Mr. William Wardell.
	Mr. William Dethick, 77, Great Cambridge-street, Hackney-road.	335,000	–	–		
	Mr. Edward Thirst, John-street, Chelsea	345,000	–	–		
	Mr. William Webster, Woolwich	350,000	–	–		
	Mr. William Hill, 203, Whitechapel-road	357,200	–	–		
	Mr. Josh. Diggle, 1, Castle-terrace, Dover	363,000	–	–		
	Mr. Rowland Brotherhood, Chippenham, Wilts	346,500	–	–		
	Mr. J. Millichamp, for Mr. W. Moxon, Dover	322,575	–	–		
Ranelagh Storm Overflow.	Mr. Francis Rummens, 40, Mecklenburgh-square, London.	35,800	–	–		
	Mr. John Newton, Montpelier road, Peckham	29,493	–	–		
	Mr. W. Moxon, 25, Parliament-street	27,600	–	–		
	Mr. W. Dethick, 77, Great Cambridge-street, Hackney-road.	23,500	–	–	Mr. Wm. Dethick, 23,500 *l.*	Mr. Richard Davis. Mr. William Bowles.
	Mr. R. Robinson, Oakland-villa, Shepherd's-bush	24,963	–	–		
	Mr. William Hill, 203, Whitechapel-road	25,926	–	–		
	Mr. Richard Batterbury, 9, Fitzroy-road, Camden-town	26,500	–	–		
	Mr. Edward Thirst, John-street, Chelsea	24,927	–	–		
	Mr. William Lavers, 40, Sutton-street, Lambeth	26,317	–	–		
	Mr. William H. Rowe, 7, Gloucester-place, Gloucester-crescent.	29,689	–	–		
	Messrs. John and Edward Bird, Hammersmith	26,779	–	–		
	Mr. John Aird, Belvedere-road, Lambeth	30,765	–	–		
	Mr. William Tredwell, 15, Parliament-street	35,435	–	–		
Ditto - - ditto (Underpinning.)	Mr. William Dethick	2,996	–	–	Mr. Wm. Dethick, 2,996 *l.*	Mr. Richard Davis. Mr. William Bowles.
Acton Branch Western Sewers.	Messrs. Walker and Neave, 141, Southwark bridge-road.	8,850	–	–	Messrs. Walker & Neave, 8,850 *l.*	Mr. James Stiff. Mr. Frederick Shadbolt.
	Mr. R. Robinson, Oakland-villa, Shepherd's-bush	9,454	–	–		
	Mr. George Axton, 41, Norland-road, Notting-hill	9,351	10	–		
	Messrs. James and Samuel Williams, Clifton-street, Notting-hill.	10,200	–	–		
	Mr. William Hill, 203, Whitechapel-road	10,129	–	–		
	Mr. Joseph Yeoman, 2, Grafton-place, Kentish-town	10,157	–	–		
	Mr. William H. Rowe, 7, Gloucester-place, Gloucester-crescent.	10,640	–	–		
	Messrs. John and Edward Bird, Hammersmith	9,945	–	–		
	Mr. W. Dethick, 77, Great Cambridge-street, Hackney-road.	10,500	–	–		
	Mr. Edward Thirst, John-street, Chelsea	9,890	–	–		
Southern High Level Sewer.	Messrs. William Dethick and E. Thirst, 77, Great Cambridge-street, Hackney-road; and John-street, Chelsea	223,000	–	–		
	Mr. William Lavers, Belvedere-road, Lambeth	229,000	–	–		
	Mr. William Moxon, 25, Parliament-street	217,800	–	–		
	Mr. William Downs, 10, Union-street, Southwark	228,760	–	–		
	Mr. Thomas Lucas, 2, Clarendon-terrace, Camberwell New-road.	217,000	–	–		
	Mr. William H. Rowe, 7, Gloucester-place, Gloucester-crescent.	218,600	–	–		
	Messrs. J. N. Helling and Co., Streatham	217,000	–	–	Messrs. Helling & Co. Messrs. Lee & Bowles, 217,000 *l.*	Wm. Lee and Wm. Bowles.
	Mr. William Webster, Asylum Works, Arlsey, Baldock, Herts.	216,750	–	–		
	Mr. George Myers, Lambeth	242,700	–	–		
Southern High Level Sewer (Continuation).	Mr. Thomas Pearson, No. 1, Bilby-place, Vauxhall	18,087	–	–	Mr. T. Pearson, 18,087 *l.*	Mr. James Stiff. Mr. Wm. Northen.
	Mr. Edward Thirst, John-street, Chelsea	23,000	–	–		
	Mr. Wm. Dethick, 77, Great Cambridge-street, Hackney-road.	23,305	–	–		
	Mr. John Walker, 141, Southwark Bridge-road	23,130	–	–		
	Mr. John W. Sawyer, Dulwich, and 10, Cannon-street, City.	31,000	–	–		
	Messrs. Hill, Keddell and Robinson, 203, Whitechapel-road.	21,100	–	–		
	Mr. Wm. Downs, 10, Union-street, Southwark	19,643	–	–		
	Mr. Wm. Webster, Charlton Wharf, Woolwich	20,400	–	–		
	Mr. James Marriot, Coventry	18,800	–	–		
	Messrs. Henry Geddes and Co., 13, President-street Goswell-road.	20,429	1	10		

* First taken by Mr. W. H. Rowe, at 264,583 *l.*, and he failed. Then by Messrs. Brassey and Co. for 329,800 *l.*

NAME of WORK.	NAMES OF PARTIES TENDERING.	£	s.	d.	Tender Accepted, showing Amount.	Names of Sureties.
Southern Outfall Sewer	Mr. Edward Thirst, John-street, Chelsea	373,000	–	–		
	Messrs. Brassey and Ogilvie, 4, Great George-street, Westminster.	331,000	–	–		
	Mr. William Dethick, 77, Great Cambridge-street, Hackney-road.	330,000	–	–		
	Mr. William Hill, 203, Whitechapel-road	328,000	–	–		
	Messrs. Newton and Fletcher, 5, Montpelier-road, Peckham.	316,059	19	8		
	Mr. William Lavers, 40, Sutton-street, Belvedere-road.	305,500	–	–		
	Mr. William Moxon, 25, Parliament-street	303,890	–	–		
	Mr. Fuller Coker, Ware, Herts	301,582	–	–		
	Mr. William Webster, Arlsey, near Baldock, Herts	300,000	–	–	Mr. Wm. Webster, 300,000 *l.*	Mr. Meaburn Staniland Mr. George Smeed.
	Mr. Joshua Diggle, Dover	Informal.				
Deptford Pumping Station.	Mr. George Myers, Lambeth	124,765	18	3		
	Mr. Wm. Webster, Charlton Wharf, Woolwich	113,900	–	–		
	Mr. Edward Thirst, John-street, Chelsea	155,371	–	–		
	Mr. Randal Stap, 32, King William-street	104,285	–	–		
	Messrs. J. Aird and Son, Belvedere-read, Lambeth	113,136	–	–	Messrs. Aird and Son, 113,136 *l.*	Mr. Jas. M. Rosseter. Mr. Joseph Quick.
	Mr. William Hill, 203, Whitechapel-road	151,049	–	–		
Deptford Pumping Engines.	Messrs. Sandys, Vivian and Co., Hayle, Cornwall	51,000	–	–		
	Williams's Perran Foundry Company, Perran-ar-Worthal, Cornwall.	47,050	–	–		
	Messrs. Harvey and Co., Hayle, Cornwall; and 12, Haymarket, London.	47,000	–	–		
	Messrs. Rothwell and Co., Union Foundry, Bolton	44,350	–	–		
	Messrs. James Watt and Co., 18, London-street, City.	34,850	–	–		
	Messrs. Martin, Samuelson and Co., Hull	31,655	–	–		
	Messrs. Benjamin Hick and Son, Bolton-le-Moors	29,945	–	–		
	Messrs. R. and W. Hawthorn, Newcastle-upon-Tyne	29,500	–	–		
	Messrs. Slaughter and Co., Avonside Iron Works, Bristol.	22,300	–	–	Messrs. Slaughter and Co., 22,300 *l.*	None.
Earl Outlet	Mr. John Aird, Belvedere-road, Lambeth	8,566	–	–	Mr. John Aird, 8,566 *l.*	Mr. Joseph Quick. Mr. Alexander Fraser
	Mr. Matthew Jenning, 2, Albert-road, Nunhead, Peckham.	11,189	11	–		
	Mr. William Lavers, 40, Sutton-street, Belvedere-road.	10,458	–	–		
	Mr. William Dethick, 77, Great Cambridge-street, Hackney-road.	10,875	–	–		
	Mr. William Hill, 203, Whitechapel-road	9,421	–	–		
	Mr. Edward Thirst, John street, Chelsea	10,960	–	–		
Portion of Southern Low Level Sewer.	Mr. John Aird	9,150	–	–	Mr. John Aird, 9,150 *l.*	None.
Southern Outfall Works	Mr. John Ward, Borstal House, Rochester, Kent	278,400	–	–		
	Messrs. Myers and Sons, Lambeth	297,986	–	–		
	Messrs. Brassey, Ogilvie and Harrison, 4, Great George-street.	327,000	–	–		
	Messrs. Hill, Keddell and Robinson, 203, White-chapel-road.	333,000	–	–		
	Messrs. John Aird and Son, Belvedere-road	323,136	–	–		
	Mr. William Webster, Burham Wharf, Belvedere-road, Lambeth.	300,000	–	–	Mr. Wm. Webster, 300,000 *l.*	Mr. Meaburn Staniland. Mr. George Smeed.
	Messrs. Edward Thirst and Co., John-street, Chelsea	315,600	–	–		
	Mr. William Lavers, Sutton-street, Lambeth	309,000	–	–		
	Mr. George Furness, 36, Great George-street, Westminster.	320,000	–	–		
	Messrs. Peto and Betts, 9, Great George-street, Westminster.	330,825	–	–		
Ditto, Engines, Pumps, &c.	Messrs. Harvey and Co., Hayle, Cornwall	59,500	–	–		
	Messrs. Hick and Son, Bolton	49,320	–	–		
	Messrs. Sandys, Vivian and Co., Hayle, Cornwall	59,000	–	–		
	Messrs. R. and W. Hawthorn, Newcastle-on-Tyne	41,500	–	–		
	Messrs. James Watt and Co. 18, London-street, City	44,900	–	–	Messrs. Watt and Co., 44,900 *l.*	None.
	Messrs. Martin, Samuelson and Co., Hull	51,000	–	–		
	Messrs. Slaughter, Gruning and Co., Bristol	50,600	–	–		
	Williams's Perran Foundry Co., Perran-Arworthal, Cornwall.	60,000	–	–		
Bermondsey Branch	Messrs. Peto and Betts, 9, Great George-street, Westminster.	97,523	–	–		
	Mr. Wm. Downs, 28, Union-street, Southwark	119,430	–	–		
	Messrs. John Aird and Son, Belvedere-road, Lambeth.	107,000	–	–	Messrs. Aird and Son, 107,000 *l.*	Mr. Jas. M. Rosseter. Mr. Joseph Quick.
	Mr. Wm. Webster, Burham Wharf, Belvedere-road, Lambeth.	119,500	–	–		
	Mr. W. Dethick, 77, Great Cambridge-street, Hackney-road.	126,077	–	–		
	Mr. W. Lavers, Sutton-street, Belvedere-road, Lambeth.	124,000	–	–		
	Messrs. W. Moxon and Co., Dover	99,875	–	–		

NAME of WORK.	NAMES OF PARTIES TENDERING.	£.	s.	d.	Tender Accepted, showing Amount.	Names of Sureties.
Western Sewers	Messrs. Ritson and Ridley, 20, Great George-street, Westminster.	65,000	–	–		
	Mr. James Marriott, Coventry	57,000	–	–		
	Mr. William Dethick, 77, Great Cambridge-street, Hackney-road.	63,861	–	–		
	Mr. E. Thirst, John-street, Chelsea	57,900	–	–		
	Mr. Joseph Diggle, 1, Castle Terrace, Dover	66,708	–	–		
	Messrs. Hill, Keddell and Robinson, 203, Whitechapel-road.	60,890	–	–		
	Messrs. W. Moxon & Co., Dover	56,740	–	–	Messrs. Moxon & Co., 56,740 *l.*	William Northen. Thomas B. W. Briggs.
	Mr. John W. Sawyer, 10, Cannon-street, City	59,927	–	–		
Southern Low Level Sewer.	Messrs. Waring, Brothers, 5, Victoria-street, Westminster.	283,518	–	–		
	Mr. George Furness, 36, Great George-street, Westminster.	350,000	–	–		
	Mr. Joseph Diggle, 1, Castle-terrace, Dover	261,000	–	–		
	Mr. William Lavers, 40, Sutton-street, Lambeth	237,500	–	–		
	Mr. William Dethick, 77, Great Cambridge-street, Hackney-road.	270,000	–	–		
	Mr. William Webster, Burham Wharf, Belvedere-road, Lambeth.	234,000	–	–	Mr. Wm. Webster, 234,000 *l.*	Mr. George Smeed. Mr. Meaburn Staniland. Mr. John G. Airries.
	Mr. Samuel C. Ridley, 20, Great George-street	215,000	–	–		
	Messrs. Hill, Keddell and Robinson, 203, Whitechapel-road.	240,000	–	–		
	Mr. William Harding, Clyde House, Lee, Kent	263,400	–	–		
	Messrs. Brassey, Ogilvie and Harrison, 4, Great George-street.	325,000	–	–		
	Messrs. W. Moxon and Co., London and Dover	282,000	–	–		
	Messrs. John Aird and Son, Belvedere-road	279,393	–	–		
Northern Outfall Reservoir.	Mr. John Jay, Metropolitan Railway, King's-cross	218,467	–	–		
	Mr. Samuel C. Ridley, 20, Great George-street, Westminster.	184,400	–	–		
	Messrs. George Myers and Sons, Lambeth	194,069	–	–		
	Mr. Stephen Lewin, Custom House-quay, Boston	191,400	–	–		
	Messrs. W. Dethick and Company, Great Cambridge-street, Hackney-road.	177,000	–	–		
	Messrs. W. Moxon and Company, London and Dover.	164,000	–	–		
	Messrs. Brassey, Ogilvie and Harrison, 4, Great George-street, Westminster.	190,000	–	–		
	Mr. Thomas Docwra, Ball's Pond-road	156,575	–	–		
	Messrs. Perry and Judson, Broadway, Stratford	194,363	–	–		
	Messrs. Hill, Keddell and Robinson, 203 Whitechapel-road.	167,907	–	–		
	Mr. Joseph Diggle, 1, Castle-terrace, Dover	169,900	–	–		
	Mr. William Harding, Clyde House, Lee, Kent	174,000	–	–		
	Mr. George Furness, 36, Great George-street, Westminster.	164,000	–	–	Mr. George Furness, 164,000 *l.*	Sir J. Paxton, M.P. Wm. Jackson, Esq., M.P.
	Messrs. Eckersley and Bayliss, 25, Parliament-street, Westminster.	131,000	–	–		
Western Sewers Extension.	Mr. William Moxon	-	-	-	Mr. Wm. Moxon, under the basis of Schedule of prices.	Mr. William Northern. Mr. Thos. B. W. Briggs.
Greenwich Sewers	Mr. Josh. F. Meston, 7, Fortess-terrace West, Kentish Town.	17,285	–	–		
	Mr. William Dethick, 77, Great Cambridge-street, Hackney-road.	22,940	–	–	Mr. Wm. Dethick, 22,940 *l.*	Mr. Richard Davis. Mr. N. Lindo.
	Mr. Thomas Pearson, Kennington-cross	27,450	–	–		
	Mr. William Lavers, Sutton-street, Belvedere-road, Lambeth.	28,300	–	–		
	Messrs. W. Moxon and Co., Fulham	29,372	–	–		
	Messrs. John Aird and Son, Belvedere-road, Lambeth.	29,530	–	–		
	Mr. E. Thirst, John-street, Chelsea	31,400	–	–		
	Messrs. Hill and Keddell, 203, Whitechapel-road.	32,300	–	–		
	Mr. William Webster, Lee-grove, Lee, Kent	35,000	–	–		
Northern Low Level Sewer.	Mr. William Webster, Wyberton-villa, Lee, Blackheath.	229,000	–	–	Mr. Wm. Webster, 229,000 *l.*	Mr. M. Staniland, M.P. Mr. T. Parry.
	Mr. W. Dethick, 77, Great Cambridge-street, Hackney-road.	233,000	–	–		
	Messrs. W. Moxon and Co., Fulham-park, Fulham	247,840	–	–		
	Messrs. Thomas Brassey and Co., 4, Great George-street.	258,000	–	–		
	Mr. George Furness, 36, Great George-street	259,000	–	–		
	Mr. Thomas Pearson, Kennington-cross	265,500	–	–		
	Mr. A. W. Ritson, 24, Norfolk-street, Strand	337,499	–	–		
	Messrs. Thorne and Co., Cremorne Wharf, Chelsea	309,746	–	–		

Appendix, No. 24.

MAIN DRAINAGE, &c. (METROPOLIS).

RETURN showing the Time when each CONTRACT was entered into, and when the Works under that Contract were to have been completed; also the Time when the Works were actually finished and delivered to the Board; also the Amount actually paid on each Contract, including extra Work, with the Name of the Contractor, and the Amount of the Contract; the same information as to Contracts still in hand.

NAME OF CONTRACT.	Name of Contractor.	Date of Contract.	Amount of Contract.	Date of Engineer's Order to Commence.	Period for Completion, from the Date of the Engineer's Order to Commence.	Period when Works were actually Finished and Delivered to Board.	Amounts Paid on each Contract. £.	s.	d.	REMARKS.
			£.				£.	s.	d.	
Northern High Level Sewer	William Moxon	14 Jan. 1859	152,430	31 Jan. 1859	15 months	December 1861	175,600	5	7	The periods stated for completion of these works are subject to alteration from various causes, such as the Board not having been enabled to obtain and put the contractor in possession of the property to be occupied for the works, legal proceedings, and other sources of delay, for which the contractor could not be responsible. December, 1863, was fixed for the termination of some of the contracts, in order to comply with the Act of Parliament at the time of letting the contract, although it was known that the time so allowed was very short for the performance of the work; and the Specification further provides that in the event of any delay occurring to the works by reason of strikes or combinations on the part of the workmen employed, the engineer may, if he think fit, allow such additional time as he may deem fair and reasonable.
Northern Outfall Sewer	G. Furness	9 Nov. 1860	625,000	4 Feb. 1861	2 years	February 1864	641,760	–	–	
Ditto - - ditto - (Fencing)	J. Horton, jun.	20 Dec. 1859	2,422	- -	6 months	July 1860	2,422	–	–	
Middle Level Sewer (North)	W. H. Rowe Brassey & Co.	20 Feb. 1861	12,451 329,800	4 April 1860 4 Mar. 1861	2 years and 3 months	In progress	11,205 317,649	– –	– –	
Ranelagh Storm Overflow	William Dethick	5 June 1860	23,500	5 July 1860	9 months	October 1862	31,826	6	10	
Ditto - - ditto - (underpinning)	William Dethick	16 Aug. 1860	2,995	- -	4 months	January 1861	2,994	13	2	
Acton Branch Western Sewers	Walker & Neave	11 Aug. 1859	8,850	17 Aug. 1859	8 months	June 1860	9,820	11	10	
Southern High Level Sewer	Helling & Co. Lee & Bowles	3 Aug. 1859	217,000	26 Sept. 1859	20 months	December 1862	207,294	15	–	
Ditto - - ditto - - (continuation)	T. Pearson	12 Dec. 1861	18,687	15 Jan. 1862	9 months	June 1863	19,374	9	2	
Southern Outfall Sewer	William Webster	6 Mar. 1860	300,000	23 April 1860	2 years	May 1862	310,648	2	6	
Deptford Pumping Station	Aird & Son	2 May 1861	113,136	6 May 1861	18 months, but may be extended.	February 1863	96,196	–	–	
Ditto - - ditto - - (engines)	Slaughter & Co.	8 Mar. 1860	22,300	- -	30 June 1861, but may be extended.	First two, 4 May 1864; next two about July 1864.	21,000	–	–	
Earl Outlet	John Aird	28 Mar. 1860	8,566	2 April 1860	6 months	September 1860	8,050	–	–	
Portion of Southern Low Level Sewer	John Aird	17 Aug. 1860	9,150 6,500	- -	Work carried on night and day, without intermission.	August 1861	15,742	–	–	
Southern Outfall Works, Crossness, Kent	William Webster	9 July 1860	300,000	16 July 1862	17 months, but may be extended.	In progress	205,106	–	–	The contracts generally are to be maintained by the respective contractors in complete repair for 12 months after their completion.
Ditto - - ditto - - (engines, pumps, &c.)	Watt & Co.	10 Oct. 1862	44,900	10 Oct. 1862	17 months, but may be extended.	ditto	11,225	–	–	
Bermondsey Branch	Aird & Son	18 Aug. 1862	107,000	20 Aug. 1862	24 December 1863	December 1863	94,977	–	–	
Western Sewers	Moxon & Co.	9 Oct. 1862	56,740	27 Oct. 1862	12 months	In progress	58,600	–	–	
Ditto - - (Extension)	William Moxon	23 Oct. 1863	On the basis of a schedule of prices.	- -	6 months, but may be extended.	ditto	3,700	–	–	
Southern Low Level Sewer	William Webster	20 Feb. 1863	234,000	2 Mar. 1863	24 December 1863	ditto	119,710	–	–	
Northern Outfall Reservoir	G. Furness	27 Feb. 1863	164,000	18 Mar. 1863	31 December 1863	ditto	153,085	–	–	
Greenwich and Deptford Sewers	William Dethick	31 Dec. 1864	22,940	14 June 1864	7 June 1864	ditto	nil.			
		£.	2,781,767			£.	2,517,986	4	1	
Thames Embankment:										
From Westminster Bridge to Waterloo Bridge.	G. Furness	27 Oct. 1863	520,000	16 Feb. 1864	2 years and 6 months	In progress	24,000	–	–	
From Waterloo Bridge to eastern end of Inner Temple.	A. W. Ritson	16 Jan. 1864	229,000	9 Mar. 1864	2 years	ditto	7,200	–	–	
		£.	749,000			£.	31,200	–	–	

Spring Gardens, 28 June 1864.

George Campion, Engineer's Accountant.

Appendix, No. 25.

MAIN DRAINAGE, &c. METROPOLIS.

RETURN showing the Time when each CONTRACT was Entered into, and when the WORKS under that Contract were to have been completed; also the Time when the Works were actually Finished and Delivered to the Board.

NAME OF CONTRACT.	Name of Contractor.	Date of Contract.	Period for Completion.	Period when Works were actually Finished and Delivered to Board.	REMARKS.
Northern High Level Sewer - - -	William Moxon -	14 Jan. 1859	15 months - -	December 1861	In some instances part of the works have been completed and given up to the Board during the progress of the remainder.
Northern Outfall Sewer - - -	G. Furnesss - -	9 Nov. 1860	2 years - - -	February - 1864	
Ditto - ditto (Fencing) - - -	J. Horton, jun. -	20 Dec. 1859	6 months - -	July - 1860	
Middle Level Sewer, North - - -	W. H. Rowe - Brassey and Co. -	20 Feb. 1861	2 years and 3 months	In progress.	The periods stated for completion of these works, are subject to alteration in the event of any delay occurring to the works by reason of strikes, or combinations on the part of the workmen employed; and the engineer may, if he think fit, allow such additional time as he may deem fair and reasonable.
Ranelagh Storm Overflow - - -	William Dethick -	5 June 1860.	9 months - -	October - 1862	
Ditto - (Underpinning) - - -	William Dethick -	16 Aug. 1860	4 months - -	January - 1861	
Acton Branch Western Sewers - -	Walker and Neave	11 Aug 1859	8 months - -	June - 1860	
Southern High Level Sewer - - -	Helling and Co. - Lee and Bowles -	3 Aug. 1859	20 months - -	December 1862	
Ditto - (continuation) - - -	T. Pearson - -	12 Dec. 1861	9 months - -	June - 1863	
Southern Outfall Sewer - - -	William Webster -	6 Mar. 1860	2 years - - -	May - 1862	These contracts generally are to be maintained by the respective contractors in complete repair for 12 months after their completion.
Deptford Pumping Station - - -	Aird and Son -	2 May 1861	18 months, but may be extended.	February - 1863	
Ditto - (Engines) - - - -	Slaughter and Co. -	8 Mar. 1860	30 June 1861, but may be extended.	1st two 4th May, next two about July 1864.	
Earl Outlet - - - - - -	John Aird - -	28 Mar. 1860	6 months - -	September 1860	
Portion of Southern Low Level Sewer -	John Aird - -	17 Aug. 1860	Work carried on night and day without intermission.	August - 1861	
Southern Outfall Works, Crossness, Kent	William Webster -	9 July 1862	17 months, but may be extended.	In progress.	
Ditto - (Engines, pumps, &c.) - -	Watt and Co. -	10 Oct. 1862	17 months, but may be extended.	ditto.	
Bermondsey Branch - - - -	Aird and Son -	18 Aug. 1862	24 December - 1863	December 1863	
Western Sewers - - - - -	Moxon and Co. -	9 Oct. 1862	12 months - -	In progress.	
Ditto - (Extension) - - - -	William Moxon -	23 Oct. 1863	6 months, but may be extended.	ditto.	
Southern Low Level Sewer - - -	William Webster -	20 Feb. 1863	24 December - 1863	ditto.	
Northern Outfall Reservoir - - -	G. Furness - -	27 Feb. 1863	31 December - 1863	ditto.	
Greenwich and Deptford Sewers - -	William Dethick -	31 Dec. 1864	7 June - 1864	ditto.	
Thames Embankment:					
From Westminster Bridge to Waterloo Bridge.	G. Furness - -	27 Oct. 1863	2 years and 6 months	ditto.	
From Waterloo Bridge to eastern end of Inner Temple.	A. W. Ritson -	16 Jan. 1864	2 years - - -	ditto	

Spring Gardens, 24 June 1864.

Appendix, No. 26.

METROPOLITAN BOARD OF WORKS.

App. No. 26.

RETURN of the Amount which has been applied to the MAIN DRAINAGE WORKS.

	£.	s.	d.
Year ending 25th March 1860 - - - - - -	179,623	5	8
,, ,, 1861 - - - - -	348,754	7	11
,, ,, 1862 - - - - - -	686,346	17	6
,, ,, 1863 - - - - - -	801,185	8	7
,, ,, 1864 - - - - - -	818,319	7	11
,, ,, 1865 (to this date) - -	129,623	4	6
	2,963,852	12	1
Deduct Amounts received back for Resales of Land, Old Materials Sold, Rents, Returns from Court of Chancery, &c. - - - - - - - -	37,034	19	6
£.	2,926,817	12	7

Spring Gardens, S.W.,
29 June 1864.

Edward Hughes,
Accountant.

SUMS Assessed (or Levied) by the METROPOLITAN BOARD of WORKS on the several Parishes, Districts or Parts, for the Years 1856 to 1864 inclusive.

		£.	s.	d.			
For Ordinary Expenses of the Board -	1856 - -	98,457	8	10			
	1857 - -	87,939	12	4			
	1858 - -	107,087	2	2			
	1859 - -	65,420	4	7			
	1860 - -	119,920	6	9			
	1861 - -	125,618	1	–			
	1862 - -	115,388	4	1			
	1863 - -	132,817	11	7			
	1864 - -	163,826	17	2			
					1,016,475	8	6
For Main Drainage - - - - -	1858–59 -	150,389	7	9			
	1859–60 -	150,535	13	9			
	1860–61 -	150,717	12	3			
	1861–62 -	155,749	–	9			
	1862–63 -	157,074	12	3			
	1863–64 -	157,349	2	3			
					921,815	9	–
				£.	1,938,290	17	6

Spring Gardens, S.W.,
28 June 1864.

Edward Hughes,
Accountant.

App. No. 26.

SUMS Raised by the METROPOLITAN BOARD of WORKS from the several Parishes, Districts and Parts, for the Years 1856 to 1864 inclusive, to the 31st May 1864.

		£.	s.	d.	
For Ordinary Expenses of the Board	1856	93,334	8	–	
	1857	83,345	1	10	
	1858	32,025	15	8	
	1859	61,050	17	–	
	1860	114,491	10	7	
	1861	119,744	18	7	
	1862	110,213	2	7	
	1863	107,237	3	3	
	1864	202	17	7	
					721,645 15 1
For Main Drainage	1858-59	150,389	7	9	
	1859-60	150,535	13	9	
	1860-61	150,717	12	3	
	1861-62	155,749	–	9	
	1862-63	157,074	12	3	
	1863-64	144,932	4	3	
					909,398 11 –
				£.	1,631,044 6 1

Spring Gardens, S.W.,
28 June 1864.

Edward Hughes,
Accountant.

RETURN of Amounts Borrowed by the METROPOLITAN BOARD of WORKS since its Formation.

	£.
Amount Borrowed for Main Drainage Works	2,950,000
Amount Borrowed for Metropolis Improvements	492,000
£.	3,442,000

N.B.—Of the above, the following Amounts have been repaid, viz.:—

	£.
For Main Drainage Works	640,000
For Metropolis Improvements	8,000
£.	648,000

Spring Gardens, S.W.,
29 June 1864.

Edward Hughes,
Accountant.

RETURN of the Estimated Amount which will be required to complete the MAIN DRAINAGE WORKS, distinguishing the Amount which will be required to finish the EMBANKMENT.

	£.
Total Estimated Cost of Main Drainage Works	4,200,000
Amount of Main Drainage Contracts let	3,010,767
Balance (which includes Compensations and other Charges upon Main Drainage Fund, some of which have been already wholly or partially liquidated) - £.	1,189,233
Total Estimated Cost of Thames Embankment North, exclusive of Mansion House Street	1,400,000
Amount of Contracts let	749,000
Balance (which includes Compensations, which are in progress of settlement) - £.	651,000
TOTAL Estimated Cost of Mansion House Street - £.	624,000

Note.—The above Estimates include both Works and Compensations, and are given as approximate only.

4 July 1864.

Metropolitan Board of Works.

Return of the Amount of Penalties, according to each Contract with those finished and those in hand, which were to be imposed for delay in completing the Works, as well as the Amount of Penalties which actually have been received by the Board.

Name of Contract.	Penalties.
Northern High Level Sewer - -	50 *l.* per day.
Northern Outfall Sewer - - -	50 *l.* "
Ditto - ditto (Fencing) - -	—
Middle Level Sewer North - -	50 *l.* "
Ranelagh Storm Overflow - -	50 *l.* "
Ditto - ditto (Underpinning) -	5 *l.* "
Acton Branch Western Sewers - -	10 *l.* "
Southern High Level Sewer - -	50 *l.* "
Ditto - ditto (Continuation) -	50 *l.* "
Southern Outfall Sewer - - -	50 *l.* "
Deptford Pumping Station - -	One per-centum on the amount of the accepted tender for each and every week between the appointed and actual time of completion.
Ditto - ditto - (Engines) - -	250 *l.* per week.
Earl Outlet - - - -	50 *l.* per day.
Portion of Southern Low Level Sewer (Gas Yard).	—
Southern Outfall Works - - -	One per-centum on the amount of the accepted tender for each and every week between the appointed and actual time of completion.
Southern Outfall Engines, Pumps, &c.	100 *l.* per week.
Bermondsey Branch - - -	50 *l.* per day.
Western Sewers - - - -	5 *l.* "
Southern Low Level Sewer - -	50 *l.* "
Northern Outfall Reservoir - -	50 *l.* "
Thames Embankment Contract (No. 1)	One per-centum on the amount of the accepted tender for each and every week between the appointed and actual time of completion.
Ditto - ditto - (No. 2)	- Ditto.
Greenwich and Deptford Sewers -	50 *l.* per day.
Northern Low Level Sewer - -	50 *l.* "

Note.—No Fines have been imposed up to the present time.

Appendix No. 27.

PAPER put in by the Chairman.

STATEMENT of the CONTRACTS for the MAIN DRAINAGE WORKS compiled from

WORKS COMPLETED.

NAME OF WORK.	Name of Contractor.	Date of Contract.	Amount of Contract.	Names of Persons who offered Tenders below the accepted Tenders, but whose Tenders were not Accepted.
			£.	
Northern High Level Sewer	William Moxon	14 Jan. 1859	152,430	- - - -
Northern Outfall Sewer	George Furness	9 Nov. 1860	625,000	- - - -
Ditto - ditto (fencing)	J. Horton, jun.	20 Dec. 1859	2,422	- - - -
Ranelagh Storm Overflow	William Dethick	5 June 1860	23,500	- - - -
Ditto - ditto (underpinning)	William Dethick	16 Aug. 1860	2,995	No competition
Acton Branch Western Sewers	Walker & Neave	11 Aug. 1859	8,850	- - - -
Southern High Level Sewer	Helling & Co., Lee & Bowles.	3 Aug. 1859	217,000	Webster, 216,750 *l.*
Ditto - ditto (continuation)	T. Pearson	12 Dec. 1861	18,087	- - - -
Southern Outlet Sewer	William Webster	6 Mar. 1860	300,000	- - - -
Deptford Pumping Station	Aird & Son	2 May 1861	113,136	R. Strapp, 104,285 *l.*
Ditto - ditto (engines)	Slaughter & Co.	8 Mar. 1860	22,300	- - - -
Earl Oultet	John Aird	28 Mar. 1860	8,566	- - - -
Portion of Southern Low Level Sewer	John Aird	17 Aug. 1860	9,150 6,500	No competition
Bermondsey Branch	Aird & Son	18 Aug. 1862	107,000	Peto & Betts, 97,523 *l.* Moxon & Co., 99,875 *l.*
	TOTAL of Works completed	£.	1,616,936	- - - -

WORKS IN PROGRESS.

NAME OF WORK.	Name of Contractor.	Date of Contract.	Amount of Contract.	Names of Persons who offered Tenders below the accepted Tenders, but whose Tenders were not Accepted.
Middle Level Sewer, North	W. H. Rowe, Brassey & Co.	20 Feb. 1860	12,451 329,800	- - - -
Southern Outfall Works (Crossness)	William Webster	9 July 1860	300,000	Myers & Son, 297,986 *l.* John Ward, 278,400 *l.*
Ditto - engines, pumps, &c.	Watt & Co.	10 Oct. 1862	44,900	R. & W. Hawthorn, 41,500 *l.*
Western Sewers	Moxon & Co.	9 Oct. 1862	56,740	- - - -
Ditto (Extension)	Wm. Moxon	23 Oct. 1863	On the basis of a schedule of prices.	- - - -
Southern Low Level Sewer	William Webster	20 Feb. 1863	234,000	Ridley, 215,000 *l.*
Northern Outfall Reservoir	George Furness	27 Feb. 1863	164,000	Eckersley & Bayliss 131,000 *l.* Tho. Docwra, 156,571 *l.*
Greenwich and Deptford Sewers	William Dethick	7 June 1864	22,940	J. F. Meston, 17,285 *l.*
Thames Embankment (No. 1)	George Furness	27 Oct. 1863	520,000	Ridley, 495,000 *l.* Baker.
Ditto - ditto (No. 2)	A. W. Ritson	16 Jan. 1864	229,000	- - - -
	TOTAL of Works in Progress	£.	1,913,831	- - - -
		TOTALS - £.	3,530,767	- - - -
Northern Low Level Sewer	William Webster	- £.	229,000	- - - -

- - - - - - - Appendix No. 27.

- - - - - - - PAPER put in by the Chairman.

the Returns furnished by the Metropolitan Board of Works. 28 June 1864.

- - - - - - - - WORKS COMPLETED.

Money included in Amount of Contract as a Provision for Extra Works (in addition to Materials included for the same Purpose).	Amount Paid on each Contract.			Amount paid over and above the Amount of Contract (in Addition to the Money included in the Contracts for extra Work).			Amount paid for extra Works (in Addition to the extra Quantities of Materials provided in the Specifications).			Time for completing the Works.	Actual Time occupied in completing the Works.	REMARKS.
£.	£.	s.	d.	£.	s.	d.	£.	s.	d.			
10,000	175,600	5	7	23,170	5	7	33,170	5	7	15 months -	35 months.	
40,000	641,760	–	–	16,760	–	–	56,760	–	–	2 years -	3 years.	
Not known if any.	2,422	–	–	- nil	-	-	-	-	-	6 months -	6 months.	
Not known if any.	31,826	6	10	8,326	6	10	8,326	6	10	9 months -	27 months.	
Not known if any.	2,994	13	2	- nil	-	-	-	-	-	4 months -	5 months.	
Not known if any.	9,820	11	10	970	11	10	970	11	10	8 months -	10 months.	
10,000	207,294	15	–	- nil	-	-	294	15	–	20 months -	3 years and 3 months.	
2,000	19,374	9	2	1,287	9	2	3,287	9	2	9 months -	17 months.	
45,000	310,648	2	6	10,648	2	6	55,648	2	6	2 years -	2 years.	
10,000	96,196	–	–	- nil	-	-	-	-	-	18 months, but may be extended.	21 months.	
- nil - -	21,000	–	–	- nil	-	-	-	-	-	16 months, but may be extended.	4 years and 2 months.	
Not known if any.	8,050	–	–	- nil	-	-	-	-	-	6 months -	6 months.	
Not known if any.	15,742	–	–	92	–	–	92	–	–	Work carried on night and day without intermission.	August 1861.	
10,000	94,977	–	–	- nil	-	-	-	-	-	16 months -	16 months.	
127,000	1,637,706	4	1	61,164	15	11	158,549	10	11			

- - - - - - - - WORKS IN PROGRESS.

15,000	11,205 317,649	– –	– –	-	-	-	-	-	-	2 years and 3 months.	- -	This contract was first taken by Mr. W. H. Rowe for 264,533 *l.*, the next highest tender being Mr. Moxon, 322,575 *l.*; Mr. Rowe failed, and the contract was re-advertised, when the lowest tender was that of Messrs. Brassey & Co., for 329,800 *l.*
30,000	205,106	–	–	-	-	-	-	-	-	17 months, but may be extended.		
- nil - -	11,225	–	–	-	-	-	-	-	-	17 months, but may be extended.		
7,000	58,600	–	–	1,860	–	–	-	-	-	12 months.		
- nil - -	3,700	–	–	-	-	-	-	-	-	6 months, but may be extended.		
20,000	119,710	–	–	-	-	-	-	-	-	10 months.		
10,000	153,085	–	–	-	-	-	-	-	-	10 months.		
Not known, if any.	- nil	-	-	-	-	-	-	-	-	7 months (supposed.)		
70,000	24,000	–	–	-	-	-	-	-	-	2 years and 6 months.		
35,000	7,200	–	–	-	-	-	-	-	-	2 years.		
187,000	911,480	–	–	—								
314,000	2,549,186	4	1	—								
15,000 (lowest)	—			—								

Appendix, No. 28.

App. No. 28.

PAPER put in by the Chairman.

FROM the Specifications, &c. submitted to the Committee, it appears that, besides additional quantities of materials (technically called "Provisional Quantities") which are allowed, the following Sums of Money are included in the Respective Contracts as a Provision for Extra Works.

—	Name of Contract.	Amount.	—
		£.	
1858	Northern High Level Sewer - - -	10,000	
1860	Northern Outfall Sewer - - - -	40,000	
1860	Middle Level Sewer - - - - -	15,000	
1859	Middle Level Sewer - - - - -	15,000	
1862	Western Sewers - - - - -	7,000	
1863	Northern Outfall Works - - - -	10,000	
1864	Northern Low Level Sewer - - -	15,000	
1863	Thames Embankment (Contract No. 1.) - also	50,000 20,000	 for ornamental figures and lamp standards.
1863	Thames Embankment (Contract No. 2.) - also	25,000 10,000	 for ornamental figures and lamp standards.
1859	Southern High Level Sewer - - -	10,000	
1859	Southern Outfall Sewer - - - -	45,000	
1861	Deptford Pumping Station - - -	10,000	
1861	Works in connection with Southern High Level Sewer.	2,000	
1862	Southern Low Level Sewer - - -	20,000	
1862	Southern Outfall Works (Crossness) - -	30,000	
1862	Bermondsey Branch - - - - -	10,000	
1860	Deptford Pumping Engines - - -	Nil.	
1862	Southern Outfall Engines - - - -	Nil.	
	£.	344,000	

Appendix, No. 29.

METROPOLITAN BOARD OF WORKS.

App. No. 29.

LETTER from Mr. *Bazalgette* to the Metropolitan Sewage Committee.

Engineer's Department,
Spring Gardens, S.W.,
4 July 1864.

My Lords and Gentlemen,

IN obedience to your directions, I submit the following observations in reply to some of the statements made to your committee on Thursday last.

It was suggested or asserted—

1st. That the Northern Main Drainage Reservoir at Barking Creek was constructed of less area, depth, and cubic contents than contracted for; and that Mr. Furness, the contractor, had been paid beyond the amount of the contract, which was said to be not yet completed, in opposition to my assertions to the contrary. (*See* Answers 5136–42, 5305–10, 5208–9, 5313–5, 5413–7, 5586.)

To these allegations I now reply by the four following certificates:—

(No. 1.)

"We, the undersigned surveyors having been previously in no way employed in preparing the contract drawings, or in the execution of the Northern Outfall Reservoir, did on the 28th and 29th days of June last, jointly measure the areas and heights of the four compartments of that reservoir at the outlet of the Main Drainage Works, situate at Barking Creek. Upon comparing such measurements with the measurements given on the contract drawings upon which the tenders for the construction of this work were based, we find that the reservoir, as constructed, is somewhat larger both in depth and area than is shown upon the contract drawings.

	Ft.	*in.*
The drawings show the depth of the reservoir at the upper end to be -	15	0
The actual depth is - - -	15	9
The drawings show the depth of the reservoir at the lower end to be -	17	6
The actual depth is - - -	17	9

"The four compartments of the reservoir are capable of storing 6,243,000 cubic feet.

"There is also an additional space at the outfall and adjoining the reservoir, capable of storing a further amount of about 242,000 cubic feet, and making the total storage room 6,485,000 cubic feet.

(signed) "*William Crane.*
"*James Lemon.*"

(No. 2.)

"4 July 1864.

"I HEREBY certify that the brickwork and stone paving of the Northern Outfall Reservoir is now completed, that three of the four compartments have been filled with sewage, and that the sewage can now be turned into the fourth compartment, and that some minor and unimportant works only remain to be done. The work is practically completed.

(signed) "*Edmund Cooper*,
"Resident Engineer."

(No. 3.)

"4 July 1864.

"I HEREBY certify that the contract for the Northern Outfall Reservoir was let to Mr. George Furness, contractor, for the sum 164,000 *l.*; and that up to the present time he has received the sum of 153,085 *l.* on account of that contract, and no more.

(signed) "*George Campion*,
"Engineer's Accountant."

(No. 4.)

"Spring Gardens, 4 July 1864.

"I HEREBY certify that I have measured and valued all the works executed under the Northern Outfall Reservoir contract up to the 11th June, which, at that date, amounted to 165,539 *l.*; and the contractor has been paid, upon these works, the sum of 153,085 *l.*, and no more.

(signed) "*Edmund Cooper*,
"Resident Engineer."

2d. That the coffer-dam described in the 14th clause of the specification for the Northern Outfall Reservoir had not been constructed as stated by me, and that the contractor, Mr. Furness, would derive the benefit of this omission. (*See* Answers 5339–5351, 5421, 5425–5434, 5571–5573, and 5590–5593.)

To this I reply by the following certificate:

NORTHERN OUTFALL RESERVOIR.

We hereby certify that a piled and clay coffer-dam has been constructed by the contractor, Mr. Furness, along the reed shore of the River Thames, for the protection of the river bank during the formation of the reservoir; and, in conformity with the 14th clause of the specification, also a second dam in Barking Creek; and that we were engaged in superintending the construction of those dams. The ends, and some other portions of the main coffer-dam, and of the Barking Creek dam, have since been removed, but a length of about 400 feet of the main dam still exists.

(signed) *Edmund Cooper*,
Resident Engineer.
John Garton,
Superintending Clerk of Works.
William Barnes,
Clerk of Works.
Edward Eade,
Clerk of Works.

App. No. 29.

3d. That Mr. Webster, the contractor for the Southern Low Level Sewer was allowed to deviate from the line of sewer laid down upon the contract drawings, and that he, and not the public, derived the benefit from such deviations. (*See* Answers 5495–5498; 5501–5509.)

The official documents, which will be laid before the Committee by the Chairman of the Metropolitan Board of Works, will show that the deviations referred to were made by orders of the Board, after careful consideration, for the benefit of the public, and that, whilst the contractor saved the cost of compensations for passing through private property, he was on the other hand bound under an agreement with the Board to execute a considerably longer length of sewer, and make good the public roads, without charging for such extra length of works.

4th. That the provision of 10 per cent. in money for extra works in the specifications of the Metropolitan Board is unusual. (*See* Answers of Messrs. Ridley and M'Cormick, 5,503 and 5507; although Mr. M'Cormick states, 5,508, that he has known Mr. Rendall to do the same thing in his works at Birkenhead.)

The specifications which will be shown to the Committee by the Chairman of the Metropolitan Board of Works show that this provision was made by the Metropolitan Commissioners of Sewers before the existence of the Metropolitan Board of Works; and it has since been adopted by the Board after careful revision, under competent legal advice. The object of this clause is that, at the outset, the estimate and tender may represent to the ratepayers and the public more fairly the probable actual cost of the work.

It is usual for engineers, in making estimates, to add 10 per cent. to cover contingencies which cannot be foreseen, but which, in the execution of works, more particularly works of this character, are sure to arise. (*See* the opinions of the late Sir William Cubitt and Mr. Robert Stephenson. Answer 5118). Extra works and omissions are measured and valued according to a schedule of prices attached to the specification, and the contractor is paid the sum so arrived at, in addition to or subtracted from, his contract price; so that if the extra works, when measured, amount to less than the 10 per cent. provided, the balance is not paid to the contractor, and the original provision thereof is neither an advantage nor a disadvantage to him.

5th. It was assumed that the clause in the Thames Embankment Specifications provide that all the materials for filling in behind the embankment should be taken from the bed of the river, and that Mr. Furness, the contractor for Contract No. 1, was taking all from other sources at a profit to himself, and a loss to the ratepayers of 80,000 *l.* (*See* Answers 5445 to 5487; 5532 to 5534; 5537 to 5539.)

Upon this point all the evidence has been directed to Mr. Furness's Contract No. 1, and no allusion has been made to Mr. Ritson's Contract No. 2, although it is a fact that on Mr. Ritson's Contract No. 2, nearly double the quantity of material for filling has been obtained from other sources (as will appear from the following certificates) than on Mr. Furness's Contract No. 1.

I submit that the interpretation put upon the clause of the specification is erroneous, and could, if permitted, produce contractors who tendered for these works to prove that they did not so interpret it; for is it a fact that all the filling in behind the embankment, up to the present time, has been made with materials not derived from the bed of the river, as will appear from the following certificates, Nos. 5, 6, and 7.

(No. 5.)

Metropolitan Board of Works,
Engineer's Department,
Spring Gardens, S.W., 1 July 1864.

Thames Embankment North, Contract No. 2.
A. W. Ritson, Contractor.

The total quantity of filling in on foreshore of River Thames, under this contract, and up to this date, is as follows:—

Total quantity, 77,428 yards, of which
6,848 yards was chalk
56,240 „ of earth, brick-rubbish, clay, and other good binding stuff, and
14,340 yards of mixed clay and ballast supplied by the Conservators of the river.

77,428 yards in all.

(signed) *Edmund Cooper*,
Assistant Engineer.

(No. 6.)

Metropolitan Board of Works,
Engineer's Department,
Spring Gardens, S.W., 1 July 1864.

Thames Embankment North, Contract No. 1.
George Furness, Contractor.

The quantity of filling-in to this section of the works I estimate at 35,000 cubic yards, of which 10,500 yards have been supplied by the Thames Conservators.

The filling-in material is ballast, clay, gravel, ground, brick-rubbish, broken stone, &c., and is of good quality.

The works done, the materials, &c., on the ground, would amount to about 37,000 *l.*

(signed) *Thos. Lovick*,
Assistant Engineer.

(No. 7.)

Metropolitan Board of Works,
Engineer's Department,
Spring Gardens, 4 July 1864.

I hereby certify that the value of the works executed, and of the materials, &c., upon the ground at Mr. Furness's contract for the Thames Embankment, has been valued by me at 37,000 *l.*, and that I have recommended him a payment thereon of 24,000 *l.*

(signed) *Thos. Lovick*,
Resident Engineer.

No complaint has ever yet been received from the Thames Conservators, that the contractors did not take all the materials supplied by them from the bed of the river, and the contractors state they have taken all the material the Conservators have given them, and are ready and willing to take more from them; but if restricted to use only such material, their works would be seriously delayed.

They assert that they have not received the large prices which it has been stated to the Committee they have received for the material delivered to them from other sources, and they ask, will the Board pay to us as an extra any additional cost which we might yet have to pay for material beyond the price charged by the conservators?

The material which has been obtained from other sources, up to the present time, consists of clay, stone, brick, rubbish, and chalk, which has been well rammed down by carting over it, and is unquestionably superior for the formation of the Embankment to the material which has been obtained from the conservators; and being of a more solid nature, and faced with brickbats and stones, there is less of it, again, washed away by the tide than from the materials taken from the bed of the river.

The quantity of "rubbish" already put into Contract No. 1, was estimated by Mr. Ridley's assistant at 200,000 loads or yards, but afterwards reduced by him to 100,000 (5532 to 5534).

Certificate No. 5, given after actual measurement, proves the whole quantity to be 35,000 yards only, of which 10,500 have been taken from the bed of the river. It is not surprising, then, that the same witness should have guessed the value of the work done at 10,000*l.*, for which I had given a certificate of 24,000*l.*, and which certificate No. 5, proves to be worth 37,000*l.*

In conclusion, I beg to observe that up to this time (Monday morning) I have seen only a portion of the notes of the evidence taken on Thursday, and I have not had time properly and fully to rebut the allegations which have so suddenly and unexpectedly been brought against me. I submit herewith, and beg to draw the attention of the Committee to, the report of the Metropolitan Board of Works upon the nature of my connection with the Odessa contract (attached hereto).

(signed) *J. W. Bazalgette,*
Engineer.

METROPOLITAN BOARD OF WORKS.

REPORT of the Committee of the whole Board, on the MAIN DRAINAGE of the METROPOLIS.

Spring Gardens,
25 November 1863.

YOUR Honourable Board having, on 30th October last (No. 5), referred a Bill in Chancery, between Sir John Hare, plaintiff, and Mr. Bazalgette and others, defendants, together with a letter of Mr. Bazalgette's to your Committee, for investigation and report, your Committee have very fully inquired into the several allegations of the Bill, and some points collaterally raised thereby, affecting your Honourable Board. Your engineer having read to your Committee the draft of his proposed answer to the said Bill, and having handed in a statement in writing, of his position in relation thereto, which they append for your information, and having afforded the fullest explanations on the several questions raised by the above documents, your Committee are now enabled to submit a complete statement of the facts of the case.

Your Committee find from the statements contained in the said Bill, that in the course of the year 1860, Sir John Rennie and certain other persons negotiated a concession with the Russian Government for the drainage and paving of the city of Odessa, and, to defray the expenses incurred, procured the advance of 1,000*l.* from Sir John Hare, plaintiff in the proceedings in Chancery, and agreed, the said plaintiff alleges, to repay him the money advanced, and assign him one-fourth part of the profits of the concession. Having obtained the concession, Sir John Rennie sought for a contractor to execute the work, and in February 1862, Sir John Rennie consulted Mr. Bazalgette as to a fit and proper person for that purpose, suggesting Mr. George Furness as one whom he had understood to be duly qualified, at the same time offering Mr. Bazalgette to share his profits in the concession, in consideration of his advice and assistance in the matter. Mr. Bazalgette, after examining the nature and conditions of the proposed contract, introduced Mr. Furness to Sir John Rennie. Mr. Furness ultimately became the contractor, and a tripartite agreement was entered into between Sir John Rennie, Mr. Furness and Mr. Bazalgette, whereby Mr. Furness agreed to pay five per cent. on the gross amount of his contract to Sir John Rennie and Mr. Bazalgette, and Sir John Rennie agreed to divide 3½ per cent. thereof equally with Mr. Bazalgette, the remaining 1½ to be divided between other parties instrumental in obtaining the concession. Subsequently, the commission was reduced to four per cent., and the plaintiff alleges that his claim to one-fourth of the profits of the concession has been ignored; he, therefore, prays for a declaration of his rights, and for an account. Of these previous transactions with Sir John Hare, Mr. Bazalgette states he has no personal knowledge.

Your Committee felt that the facts thus disclosed raised three points for consideration: First, had their engineer, by engaging in this business, contravened his original engagement with the Board to devote his whole time to their service: Secondly, was his position, in reference to the tripartite agreement incompatible with his duty as engineer to the Board: Thirdly, was there anything in the transaction which might impugn his personal or professional honour, or had his conduct, in reference to any of the Board's contractors, afforded grounds for questioning his impartiality or integrity.

On the first point your engineer stated that he was not acting in any way professionally in the matter, which was strictly one of bargain and sale, requiring for its conduct but a small portion of his leisure time, and which did not regard the Board any more than would the investment of money in any other concern of private life.

Your Committee, while allowing full weight to these explanations, are not prepared to concur in their conclusion; they feel the matter to be one of gravity and moment, involving necessarily considerable care in its conduct, and attended with much anxiety, and although they acquit your

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your engineer of any intentional breach of his engagement, they disapprove of his being concerned in any transaction with any contractor without the consent of the Board.

Touching the second head of inquiry, viz., whether his interest in the Odessa contract, as regulated by the tripartite agreement, was compatible with his position as engineer to the Board, your Committee feel great pleasure in stating, that at the very commencement of this inquiry, Mr. Bazalgette stated, that although, in entering into the said agreement, he believed that he was doing nothing which he had not every moral and professional right to do, yet that he was quite prepared to sacrifice all his interest in the transaction, should the Committee be of opinion that it was desirable that he should do so, and had placed in the chairman's hands a letter to Mr. Furness, annulling his agreement and renouncing all claim to any payments on account of the Odessa contract. Mr. Bazalgette stated to your Committee that he valued his good name and the confidence of the Board more than any pecuniary advantage; but, at the same time, he felt it right to point out, that pending the inquiry before your Committee, rumours prejudicial to his honour and character had been circulated out of doors, which, without full explanation, would tend to be confirmed by his relinquishment of his share in the Odessa contract, at least that unfavourable inferences might be drawn. Your Committee are, therefore, anxious to give full publicity to the fact of Mr. Bazalgette's renunciation, of his own spontaneous motion, previous to any resolution of your Committee, or to any inquiry having been commenced by them.

The third branch of their investigation has received very careful consideration at the hands of your Committee with most satisfactory results, and your Committee feel it important to state rather fully their conclusions on this head, being one which interests the general public more than Mr. Bazalgette's professional position or relation to the Board; and, doubtless, the mere statement of the fact that Mr. Furness had lately obtained an important contract under your Honourable Board in preference to competing contractors, coupled with Mr. Furness being a party to the tripartite agreement, would be not unlikely to give rise to unfavourable comment.

It may be well to remind the Board that there were 13 tenders for the Thames Embankment contract, varying from 495,000 *l.* up to 680,000 *l.*, the lowest of which was by Mr. S. C. Ridley. This being a work of great magnitude, of great public importance, and involving very serious consideration, such as, amongst others, the stability of the bridges over the Thames, it was felt that the Board would assume too grave a responsibility unless they entrusted so heavy a work to a contractor of known and tried experience, and, although they were informed that Mr. Ridley had executed works of importance in America, yet neither his operations in that or in this country were comparable to such an undertaking as the Embankment, nor were they, so far as the Board could ascertain, of a similar character. They, therefore, thought it advisable not to confide its execution to him. The next lowest tender was that of Messrs. Baker, whom your engineer stated to be one of the first firms in this country, pre-eminently qualified for the work, possessing every material requisite, as well as abundant knowledge and experience. Messrs. Baker, however, declined to enter into a contract without so serious an alteration of its conditions as rendered it impossible for the Board to accede, feeling that it would be unfair to all other parties tendering to admit one firm to tender on terms very different from those by which the others were bound. The Board, therefore, could only pass on to the next on the list, a contractor already engaged for the Board, but whom they believed at that time to be fully employed on their works, and to be, therefore, unequal to so great an additional task. Your engineer then advised your Honourable Board to abandon all other tenders, and to re-advertise for fresh ones; but the experience of the result of a similar course on former occasions was not satisfactory. Your Honourable Board, therefore, negatived a motion for issuing fresh advertisements, and took the next tender on the list—that of Mr. George Furness—knowing from their past experience of his work that he was able and willing to discharge his duty as a contractor in a satisfactory manner, and having ascertained by inquiry his financial and general competence to carry out this particular contract. Your Committee are anxious to remind your Honourable Board that this matter of the Embankment contract was very maturely considered, occupying an entire month from receiving the tenders to the acceptance of that of Mr. Furness; that every point was fully discussed either in the Board itself, or in the Committee of the whole Board, and, although assisted by the information of your engineer, it was not by his influence or advice that their ultimate determination was arrived at, but on an impartial opinion based on the evidence brought before them. Your Committee feel, therefore, no hesitation whatever in entirely acquitting your engineer of any imputations on his honour, and, after minute examination and full deliberation, although disagreeing with Mr. Bazalgette as to the wisdom or propriety of his having engaged in this transaction without the consent of your Honourable Board, are entirely satisfied that he has not in the slightest degree been impeded thereby in the discharge of his official duty, or suffered his judgment or impartiality to be warped. For these reasons they have arrived at the following resolutions, which they have unanimously agreed to submit to your Honourable Board:—

That, Mr. Bazalgette, the engineer, having been engaged with Sir John Rennie in recommending a contractor for carrying out certain works at Odessa, for which the engineer, jointly with Sir John Rennie, was to receive a commission, and the person recommended, and who undertook the same, being a contractor for the execution of works under the Board, the Committee disapprove of their engineer having been concerned in any transaction with any contractor, without the consent of the Board, and in contravention of the terms of his appointment, although in respect of works to be performed in a foreign country.

That they find that Mr. Bazalgette, from the first, expressed his readiness to relinquish all his interest in the Odessa contract, which course he has adopted.

That, after a most anxious inquiry into the whole facts of the case, they are satisfied that there has been nothing reflecting in any way on Mr. Bazalgette's professional or personal honour, and that he has throughout discharged his duty, both to the Board and their contractors, with ability, impartiality, and integrity.

(signed)
J. Thwaites.
P. H. Le Breton.
Edw. Shepherd.
E. C. Dermer.
J. S. Phillips.
Joseph Moreland.
Dennis M'Donnell.
Philip Crellin.
William Newton.
Robt. Freeman.
J. D'A. Samuda.
G. B. Richardson.
J. J. Tanner.
B. H. Adams.
Ed. Collinson.
James Pew.
Henry Bidgood.
J. Long.
Thomas D'Iffanger.
Robert Taylor.
Francis Healey.
Silas Taylor.
J. O. Hall.
Wm. Tite.
B. Dixon.

Engineer's Statement referred to in the foregoing Report.

Engineer's Department,
Spring-gardens, S.W.,
24 November 1863.

Gentlemen,

IN consequence of misrepresentations out of doors, I beg to state to you the facts relating to the Odessa matter:—

Early in 1862, Sir John Rennie proposed to me to join him in the sale to some competent contractor, of the right or interest of means, which he represented he had, of obtaining or enabling another person to obtain, a concession or contract from the Russian authorities, for the construction of works at Odessa, upon the terms of my sharing equally with him in the price of such sale; and I may here mention that the practice of bringing foreign concessions for public works to London, for sale to eminent English contractors, is a very usual transaction: indeed, it is in this manner that most of the great continental engineering works have been carried out. From Sir John Rennie's statement it was clear, that having regard to the Russian authorities, the matter must be concluded in a short time, and finding that nothing would be required of me but what I could do at my leisure hours, and within a short period, I agreed to Sir John Rennie's proposal. Mr. Furness, a well known and wealthy public contractor, eventually became the purchaser; and in the first week in March, entered into an agreement to pay Sir John Rennie and myself, in equal moieties, the stipulated purchase money, in the event of his obtaining a contract from the Russian Government, with respect to which he was at liberty to adopt his own proceedings and exercise his own discretion. The matter, so far as any service or assistance could be required of me, was concluded when the agreement was entered into in March. Some subsequent communications occasionally took place on the subject, up to the month of August, 1862; since which time I have done nothing in the matter, nor can any further service, or assistance, or interference, be required of me. In fact, I am no further concerned in the matter than simply to receive whatever money I am entitled to under the above circumstances. However, I may add that I have not yet taken any steps to obtain, nor have I received any payment. It is certain, and I think it must be obvious from this statement, that there is nothing in the matter which has interfered with, or can interfere with, the due discharge of my duty as Engineer of the Board. It will scarcely be contended that, after the fulfilment of his official duties, a public officer may not, at his leisure hours, attend to his own private affairs. The whole of my part in this transaction has in reality amounted only to a sale of my private property, carried into effect at my leisure time, and I have not acted, or intended to act, nor can I be required to act, in any manner professionally as an Engineer, with respect to the Odessa matter, or in any way which can interfere with the devotion of the whole of my professional time and services to the office I hold as Engineer of this Board. According to the agreement of March, 1862, Mr. Furness was at liberty to adopt his own course as to obtaining or abandoning the contract offered by the Russian authorities. I have never sought to influence him therein, but on the contrary, when I learned that Sir John Rennie had pressed Mr. Furness to enter into the contract with the Russian authorities upon the terms then proposed by them, and had made use of my name, without my consent, I, on the 21st April, 1862, wrote to him in the following terms:—"I learn from Sir John Rennie to-day, that you have determined to tender for the Odessa contract. I am, of course, not sorry to hear it, but never allow that for one moment to influence you in accepting or declining the terms they offer. It would be *no satisfaction* to me to find that you had obtained a bad contract, even though I might derive some benefit therefrom, and you will please me most by regarding your own interest alone in this matter."

There is obviously nothing in this Odessa business which can at all effect the relative position of Mr. Furness and myself in any other matter, and certainly it has never been thought of by me in any other transaction in which he has been concerned. I have been anxious to make these points clear, although I have from the first, in deference to views expressed, that the transaction was at variance with the terms of my original appointment by the Board, which requires the devotion of the whole of my time to its service, offered to relinquish all beneficial interest therein.

With respect to the Thames Embankment contract, most of the Members of the Board will, doubtless, remember the circumstances respecting it, which disprove the imputation that Mr. Furness obtained that contract through my influence. Having regard to the nature and difficulties of the works, and the necessity which may arise in the course of their execution requiring the application of great skill and extraordinary means for preventing damage, not only to the works in progress, but to great existing public works, it is most important that the contractor should be a person of skill and experience, and possessed of great resources. I was bound to advise the Board to this effect, and Mr. Ridley's tender was rejected.

Messrs. Baker and Son, whose tender was lower than that of Mr. Furness, in my judgment were contractors of the required description, and accordingly were recommended by me in strong terms to the Board, as well known first-class contractors, and just such as could be desired for the Thames Embankment contract. Those gentlemen, however, themselves declined to comply with some of the terms of the specification, and in consequence the Board did not give them the contract.

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The resons for passing over the next tender above that firm, are well known to the Board, and could not be affected by me, and this tender was, moreover, not passed over on account of any recommendation of mine.

Mr. Furness stood next upon the list, but instead of my having recommended him, I, on Messrs. Baker and Son declining, suggested on several occasions that the contract should be re-advertised for fresh competition. The unfavourable result of past experience in re-advertising former contracts induced the Board to reject this. Had Messrs. Baker and Son been willing to accept the terms of the contract, my recommendations, both respecting them and as to re-advertising, would have prevented Mr. Furness from obtaining the contract. When, moreover, in answer to questions put to me in my official capacity by an Honourable Member, on the 16th October 1863, I stated, as I was in honesty bound to do, that I considered Mr. Furness a proper and competent contractor. I premised that answer in the following terms:—"After the recommendations which I have felt it my duty to make with reference to the non-acceptance of Mr. Ridley for this work, I should have been glad to have avoided offering any opinion with respect to the merits of any particular contractor, and should have preferred leaving the selection entirely in the hands of the Committee, desiring only that they should appoint some well known and tried contractor for this difficult work."

The proceedings respecting the Thames Embankment contract took place in the presence of a committee of the whole Board, and are, therefore, within the knowledge of a large majority of the members; and having now submitted to the Board a true representation of the other matters, I rest assured that they will feel that the insinuations respecting me are unfounded and contrary to the true state of the facts, and will support their officer in the independent discharge of his public duties against misrepresentation.

I have, &c.
(signed) *J. W. Bazalgette*,
Engineer

To the Metropolitan Board
of Works.

Appendix, No. 30.

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LETTER from Mr. *E. Burstal*, to Lord *Robert Montagu*, M.P.

Thames Conservancy,
Offices, 41, Trinity Square,
Tower Hill, E.C.,
14 July 1864.

My Lord,

IN reply to your note I have to inform you that the contractor for No. 1 Section, of the Thames Embankment, Mr. Furness, has not taken any material from the Thames Conservancy, dredgers since June 7th, that on that day the Engineer to this Board received a letter from Mr. Williams, the lighterman, stating that Mr. Furness would not take any more material from the dredgers. The consequence is that since June 7th all the dredged material from the river that has been supplied from this service, has been sent to No. 2 Section, Mr. Ritson's contract, which has been equal to about four barge loads, or 140 yards a day.

In consequence of this small demand the dredgers have been for a long time unoccupied.

I have, &c.
(signed) *E. Burstal*,
Secretary.

The Lord Robert
Montagu, M.P.

MEMORANDUM of Material supplied by Thames Conservancy for filling in the Thames Embankment.

RITSON'S CONTRACT.

March - - - - -	3,828	yards.
April - - - - -	3,415	„
May - - - - -	3,185	„
June - - - - -	3,619	„
TOTAL - -	14,047	„

FURNESS' CONTRACT:

April - - - - -	3,691	yards.
May - - - - -	5,054	„
June - - - - -	1,713	„
TOTAL - -	10,458	„

No supply since 7 June.

E. Burstal.

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Ellis

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Further citation of the authority of Professor Way, as showing that sewage applied beyond a certain limit is valueless, *Ellis* 2427–2429——There have been several experiments conclusive as to the limited absorption of fertilising matter per acre, *ib.* 2430, 2431. 2463——Increased knowledge of the question, which induces witness to conclude that an average application of as much as 500 tons per acre is undesirable, *ib.* 2432–2442. 2507–2510. 2532——Further examination in support of the conclusion that sewage can most advantageously be supplied in small quantities, *ib.* 2460–2478.

Opinion that the sewage of from seven to ten persons would be quite sufficient for each acre, *Whitehead* 2880–2883——For grass land these should be about four or five dressings a-year, at the rate of 100 tons for each dressing per acre, *Mechi* 3348. 3353——Opinion that from 500 to 1,000 tons per acre yearly, in five or six dressings, is a fair quantity for grass land, *Walker* 3622–3624. 3658–3663.

Limit to the power of the earth to extract the manurial properties of sewage, so that waste arises where there are very large applications, *Dales* 3750–3753; *Lawes* 4361–4370. 4473–4479——The crop is not increased at all in proportion to the increased application of sewage, *Lawes* 4351. 4381–4385. 4423——With 3,000 tons of sewage 22 tons per acre

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5. *Quantity of Sewage to be applied per Acre*—continued.

acre were obtained at Rugby; with 6,000 tons, 30 tons; and with 9,000 tons, 32 tons per acre, *Lawes* 4351——Very great improvement of land, more especially of sandy soils, if the London sewage were distributed over it at the rate of 1,000 tons an acre, *ib.* 4459–4468. 4475–4483.

It was found at Rugby that a small quantity over a large area did not answer, *Lawes* 4502. 4512, 4513——Estimate of 6,000 tons per acre as the quantity which might be applied if the farmer had to pay ½ *d.* a ton for it; the quantity, however, varying with the soil, *ib.* 4562–4584——Advantage of 30,000 or 50,000 tons an acre, if it could be had for nothing, *ib.* 4567. 4571–4578——Whether, on soil like that at Rugby, or on sandy soil, witness would use 50,000 or 70,000 tons per acre if it were delivered for nothing, *ib.* 4678–4680.

Limit to the power of the soil and of vegetation to absorb sewage, *Way* 4735–4738——With regard to Mr. Lawes having recommended large applications of sewage over a small area, witness shows that, in order to prevent waste, and to get the full value of the sewage, it should be applied in small quantities over a large area, *ib.* 4795–4817. 4946, 4947——The question of small or large applications must, however, depend upon the expense of the works, and the value of the crops to be obtained, *ib.* 4800–4806——Waste of fertilising matter if the sewage water passes into the drains in a discoloured state, *ib.* 4808–4817——Witness would like to apply the sewage of from 50 to 100 people per acre; that is, from 3,000 to 6,000 tons per annum, *ib.* 4949, 4950. 4983, 4984.

Conclusion that although the full manurial value of sewage can only be obtained by putting it on the land in small quantities; it would never pay to apply it in this way over a large area, *Way* 4851–4858. 4946–4948. 4976–4979. 5003.

Resolutions passed by different vestries, or at public meetings of ratepayers, in favour of the application of sewage in moderate dressings, *App.* 451–454.

6. *Probable Value to be attached to Sewage by Agriculturists, and Price to be obtained per Ton:*

Probability of farmers becoming more alive to the value of the sewage as a manure, *Thwaites* 228. 235–237——Witness is not prepared to give any definite opinion as to the actual value of the sewage as applied to agriculture, *ib.* 252. 292–295. 303. 349–356——Impression that the holders of the marsh lands about Barking, Erith, &c., would not, in the first instance, be disposed to pay a rent for the sewage, *Bazalgette* 322–324——Probable value of the sewage to farmers; difficulty of judging from the scientific value, *Hope* 518. 568–572——Objection to any plan which depends upon the farmers taking the sewage, *Sir C. Fox* 1295, 1296. 1302——Anticipated litigation if the company advocated by witness had to deal with farmers instead of cultivating the land themselves, *ib.* 1460–1464.

Although Professor Liebig estimates the value at 1⅓ *d.* per ton, a penny per ton is more than the farmers would at present give for it, *Smith* 1565, 1566——Calculation that the liquid sewage is worth, throughout the year, an average of 1¼ *d.* per ton to the farmers, *Shepherd* 1618–1620——Probability of the farmers readily paying 1 *d.* per ton for a limited quantity, but not 2 *d.* per ton, *Ellis* 2046, 2047——In order to obtain a good price for the sewage, as applied to agriculture, it should be taken to a distance from towns, *ib.* 2418——Two-fold objection to any company utilising the sewage on land in their own possession, as compared with its being offered to the farmers, *ib.* 2458, 2459. 2530.

Belief that farmers would, in time, gladly avail themselves of town sewage, and would be ready to pay from 2 *d.* to 3 *d.* a ton for it; illustration in witness's case, *Mechi* 3350–3352. 3436–3441——Conclusion as to town sewage being less valuable as a manure than it was formerly supposed to be; doubt as to to its actual value, *Acland* 3468, 3469. 3494. 3601——Willingness of farmers to pay a moderate price for town sewage, *Dales* 3769.

If witness, as a farmer, were obliged to take the London sewage all the year round, he could not give ½ *d.* a ton for it, but could give 2 *d.* a ton if allowed to take it as he pleased, *Lawes* 4521–4533. 4568. 4583——Risk in giving as much as ½ *d.* a ton for 6,000 tons delivered on the land throughout the year, *ib.* 4568. 4584——The more witness had to pay for the sewage, the less he would use, *ib.* 4681——At ¼ *d.* a ton, he would begin by using 5,000 or 6,000 tons an acre, but not more than 4,000 tons, if so much, if he had to pay ½ *d.* a ton: much would depend upon whether he had to find pipes and hose, *ib.* 4682–4688——At 1½ *d.* or 2 *d.* a ton witness would rather be without the sewage, unless he could use it when he liked, *ib.* 4689–4691.

The value of the sewage as applied to agriculture cannot be inferred from the chemical value, *Way* 4843, 4844. 4892. 4957–4962. 4990–4992——Anticipated refusal of farmers to take the sewage if bound to take large quantities at any time, *ib.* 4859, 4860. 4900. 4937——Important benefit of sewage to farmers if they might take it when they pleased, and if the company supplying it could themselves utilise all that was not required by the farmers, *ib.* 4928–4931. 4993–4995——The commercial value of sewage manure, that is,

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6. *Probable Value to be attached to Sewage, &c.*—continued.

as applied to agriculture, will probably be enhanced through the failing supply of guano, &c., in proportion to the demand, *Way* 4963–4965. 5002, 5003——Witness would rather not have any sewage if required to take it at all times, *Congreve* 5057–5062.

Calculations submitted by Messrs. Napier & Hope as to the practical value of sewage as a manure, *App.* 465, 466.

Reference by the Committee to the prospect of increased pecuniary benefit from the use of sewage in agriculture, on account of the insufficiency of the supply of artificial manures, *Rep.* v.

See also *Alnwick. Anerley Schools Farm. Artificial Manure. Croydon. Edinburgh. Essex, Earl of. Grass Land. Italian Rye-grass. Landowners. Liebig, Baron. Liquid Sewage or Manure. Mangel Wurtzel. Manure. Monopoly. Palmerston, Lord. Profitable Application of Sewage. Rugby. Sandy Soils. Solid Manure. Tenders. Tiptree Hall Farm. Value of Sewage. Wheat.*

Aire River. Exceedingly polluted state of the River Aire, which passes through Leeds and Bradford, *Rawlinson* 4063, 4064.

Aldgate Ward Ratepayers' Association. Resolution passed by this association, on 30 May 1864, in favour of the sewage being so dealt with by the Metropolitan Board, that the ratepayers may be largely interested in the total profits derived, instead of the system of a fixed annual rental being adopted, *App.* 454.

Alnwick (Northumberland). Probable explanation as to some sewage-pumping works erected by the Duke of Northumberland having never been made use of by the local farmers, though asked to pay merely the expense of pumping, *Ellis* 2089–2092.

Examination with further reference to the refusal of the farmers to avail themselves of the sewage-pumping works erected by the Duke of Northumberland; question more especially whether there may not have been an apprehension that poisonous matter, or chemical refuse, was introduced into the sewage, *ib.* 2536–2548. 2586–2590.

With regard to the sewage of Alnwick not having been utilised by the farmers, though given great facilities by the Duke of Northumberland, witness explains that it is of a very inferior character, *Dales* 3754–3756.

General use of water-closets at Alnwick, where the sewage, refused by the farmers on account of the cost of pumping, is of an excellent quality, *Rawlinson* 4178–4183. 4243–4245——Entire inaccuracy of the statement by Mr. Dales, as to the poor character of the Alnwick sewage, *ib.* 4216, 4217.

Memorandum containing sundry particulars relative to the use of town sewage at Alnwick; abandonment of the experiment in 1862, because of the returns not compensating for the expense, *App.* 262–265.

Ammonia. Witness considers that there are not more than from 12 to 13 pounds of ammonia in 100 tons of London sewage, *Lawes* 4631——Great variation in the amount of ammonia in two different samples of the Rugby sewage, *ib.*

Results of numerous analyses by witness of the Rugby sewage, as regards the quantity and value of the ammonia therein, *Way* 4848–4850. 4892, 4893. 4990, 4991——Large proportion of the ammonia which is absorbed in the land at Rugby, *ib.* 4873, 4874——Calculation that the ammonia in the London sewage is worth only ½ *d.* or ¾ *d.* a ton, the commercial value being much less than this, *ib.* 4955–4962.

See also *Value of Sewage.*

Amount or Quantity (London Sewage). Total of about 168,000,000 tons of sewage on the north side annually, *Bazalgette* 97–99——Enormous amount of the annual sewage of London, including the rainfall, *Thwaites* 225–227——The daily flow of the London sewage has been calculated at 81,250,000 gallons, *Smith* 1403——Information as to the total quantity of the sewage from the north and south side, as estimated by Messrs. Hofmann & Witt, by Mr. Bazalgette, and by witness, respectively, *Ellis* 1739–1764——Total annual quantity of 266,052,441 tons estimated by witness, *ib.* 1764.

Calculations in letter from Lord Torrington and others to the Chairman and Members of the Committee, as to the amount of sewage to be dealt with, *App.* 472, 473.

Paper containing calculations, in connection with the scheme of Messrs. Napier & Hope, as to the volume of London sewage, *App.* 465.

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Analyses of Sewage. See *Value of Sewage.*

Anerley Schools Farm. Equally good crop of Italian rye-grass obtained upon the farm at the Anerley schools, from small applications of sewage, as from large applications, *Ellis* 1820–1822.

Application or Distribution of Sewage. See *Agriculture. Gravitation. Hose and Jet. Open Gutters. Pipes and Mains.*

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Arbitration (*Contracts, Board of Works*). Grounds for disapproving of the system of the Board not allowing the arbitration clause in their contracts; effects of this exclusion in limiting competition, and in causing more expensive contracts, *Roche* 5672–5674. 5678–5681. 5693–5698. 5705. 5712–5715——Division, at the Metropolitan Board, on the subject of the arbitration clause; small majority in favour of its exclusion, *Roche* 5702–5704. 5616. 5720——Objection to the non-adoption of the arbitration clause in the Board's contracts, as excluding eligible contractors from competition, *Nicholay* 5767–5769. 5774–5777. 5820.

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Artificial Manures. Interest of dealers in artificial manure to depreciate the value of town sewage, *Ellis* 2417, 2418. 2539–2542——Considerable adulteration in artificial manures, *Mechi* 3359.

Improbability of the utilisation of town sewage having any effect in depreciating the price of artificial manure, *Lawes* 4376–4378——Inexpediency alike of too large a use of artificial manure and of sewage manure, *ib.* 4379–4385——Very large amount of witness's interest in artificial manures, *ib.* 4399–4403——Very immaterial effect of artificial manures upon the permanent quality of the soil, *ib.* 4455–4458.

Object of the use of artificial manures to restore fertilising power to the land, as well as directly to increase the crops, *Way* 4755–4759——Estimated quantities of different artificial manures used in Great Britain and Ireland, with the price of each per ton, *ib.* 4772–4784——Effect of an extensive use of sewage as a manure in preventing the prices of artificial manures from increasing, which otherwise they are very likely to do, *ib.* 4785–4788——Opinion that the use of sewage manure will not, however, lower the present price of artificial manure, as the former could be utilised only in the vicinity of towns, *ib.* 4787. 4789, 4790——Very small quantity of artificial manure used in the neighbourhood of London, *ib.* 4791——Reference to the publication by Mr. Lawes, of his private experiments, as tending to prejudice his own interests in the sale of artificial manures, *ib.* 4792–4794.

Probable increase in the commercial value of sewage manure, on account of the increasing demand for artificial manure, *Way* 4963–4965. 5002, 5003——Way in which the utilisation of sewage may act disadvantageously to the manufacturers of guano, &c., *ib.* 4966–4968——Further statement as to guano and other manures being likely to increase in price on account of the failing supply, *ib.* 4985–4989.

Reference by the Committee to the insufficiency of the supply of artificial manures, so that the pecuniary benefit from the utilisation of town sewage may, in a few years, be greatly increased, *Rep.* v——Exhaustion, in a few years, of the sources whence some of the most important artificial manures are obtained, *ib.*

Ashburton (*Devon*). Quotation of statement by Mr. Caunter, of Ashburton, as to the excellent fertilising effect of the sewage of the town, *App.* 344, 345.

Ashton-under-Lyne. See *Eureka Company.*

B.

Bagshot Heath. Statement to the effect that the London sewage may be best applied to a sandy soil, like that at Bagshot Heath, inasmuch as it would greatly improve the soil, and would partly find its way back into the Thames in a comparatively pure state, *Way* 4914–4936.

Barking (*Essex*). See *Discharge of Sewage. Essex. Gravitation. London Sewage Utilisation Company. Northern Outfall Reservoir.*

Bateman, John Frederick. (Analysis of his Evidence.)—Has had great experience in the construction of waterworks: constructed the works for supplying Manchester and Glasgow, 2600–2608——Information relative to the amount of horse power required to raise 10,000,000 gallons of water different heights in different periods, 2609–2616——Slight additional power required to raise sewage, as compared with water, 2617–2619——Opinion that the best mode of conveying town sewage into the country is to lift it up to a reservoir, and then let it run out in conduits by gravitation, 2621. 2642——Less cost of open conduits than of iron or earthern pipes for conveying sewage in a large quantity, 2621–2626.

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of different sizes, 2633——Cost per mile of pipes of diameters varying from two feet to five feet, 2634. 2660——Quantity of water which pipes of various sizes will discharge in twenty-four hours, with reference to the head of water and the fall per mile, 2635–2638——Price of iron adverted to, with reference to the price calculated for the various pipes, 2639.

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Bazalgette, Joseph William. (Analysis of his Evidence.).—(For First Examination. See *Thwaites, John, &c.*)

[Second Examination.]—With regard to certain allegations which witness understands to have been made with respect to the main drainage system, he submits that such allegations and their authors should be made known to him, 5105–5109——The general scheme of the main drainage works was finally approved by the Metropolitan Board in 1858; 5110, 5111——The works were, in the first instance, designed piecemeal, and the plans were modified, from time to time, before they were finally adopted, 5112.

Division of the scheme into a number of contracts of convenient size, 5113, 5114. 5121, 5122——Preparation by witness, in 1858, of an estimate for the entire scheme, based upon the then value of materials and workmanship, and amounting to 2,800,000 *l.*; 5114–5118——Increased power taken for borrowing 1,115,000 *l.* in addition to the original estimate, in consequence of the great advance (about 30 per cent.) since 1860 in the value of materials, 5117–5120——The powers first taken were for 3,000,000 *l.*; 5118——Views of Mr. Robert Stephenson and Sir William Cubitt in approval of the joint estimate, and report of Mr. Haywood and witness in 1854, relative to the works on the north side, and concurring in an estimate of 3,000,000 *l.* for the entire scheme, 5118.

Statement that witness's estimate for twenty contracts, let up to 1863, were 2,725,983 *l.*, and the works were let at 2,752,327 *l.*; closeness of this approximation to the real cost, 5122–5125——Three more contracts have been let since this time last year, and there are three still remaining to be let, 5125——The rise in price occurred after one of the contracts had been let, and the contractor, Mr. Moxon, was ruined, but the Metropolitan Board did not suffer, 5126–5129.

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The area of the reservoir on the north side is 9 ½ acres, and the contents 5,426,000 cubic feet, 5136——Witness has not measured the depth of the north reservoir, but is convinced that it is of the required depth of 13 ¾ or 14 feet, 5137–5139——The area of the south side reservoir is 6 ½ acres, the depth 14 ½ feet, and the cubical contents, 4,000,000 feet, 5140——The reservoirs are covered, due provision being made for ventilation, 5141, 5142——They will each hold the cubic contents for which the contracts were made, 5143.

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Examination upon questions purporting to show that the reservoir on the north side is much too small; witness submits that it is abundantly sufficient, 5150–5183. 5284–5286——Explanation that the sewage of the western division was not at first intended to be conveyed to the reservoir, or the latter would have been planned on a larger scale, 5165. 5183.

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5183. 5285 ——Facility of adding to the size of the reservoir if found insufficient, 5165. 5168. 5183.

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The reservoir on the north side was to have been completed by 31st December 1863, but is not yet quite finished, 5208–5211. 5219, 5220——The contract for the reservoir was 164,000 *l.*; doubt whether 500 *l.* more than this amount has already been paid to the contractor, 5212–5223——Explanation as to the large items estimated in the different contracts for extra works or unforeseen contingencies, and as to the practice of payment in such cases, 5224–5236.

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Further information explanatory of the increased cost of the main drainage works beyond the original estimate of 3,000,000 *l.*; 5267–5273——Actual progress of the works further adverted to; considerable portion of the scheme already in operation, 5274–5283——Careful manner in which the work of the contractors is measured and checked by witness's staff, before payments are made, 5295–5299——Further statement relative to the size of the reservoir on the north side at Barking; conviction of witness, though he has not personally measured the reservoir, that it is of the contract size, 5300–5315.

System of contract for the engines further adverted to with reference to the question of the lowest tender having been accepted, 5316–5320——There are three assistant engineers under witness, who, as well as himself, are paid by salary exclusively, 5321–5325——Statement in further explanation of the non-adoption of Cornish engines, 5329–5336——Amount estimated by witness as the cost of a coffer-dam in connection with the north side reservoir at Barking, 5337–5346——Formation of this coffer-dam in accordance with the description set out by the Board, 5347–5351.

Examination as to the contractor for the first portion of the Thames embankment using a large quantity of clay and brick rubbish in its formation, which he is paid for taking, instead of material dredged from the Thames, as contemplated under the specification, 5352–5368——The conservators do not supply material fast enough for the work, 5361. 5366——Probable large reduction in the amount of the contract, if it had been known that material could be obtained from the land at 8 *d.* or 1 *s.* a load for taking it; doubt as to so large a saving as 20,000 *l.* on this score, 5363. 5365–5368. 5375–5378——Witness cannot name any works as having been performed by Mr. Furness, similar in character to the embankment, 5369–5374.

[Third Examination.]—Explanation that there is still 11,000 *l.* in hand out of the contract price of the north side reservoir, 5823——Much larger cubical contents of the reservoir, including the penstocks, than was before stated by witness, 5823, 5824——Circumstance of the reservoir being deeper and larger than the contract size, instead of smaller, 5825——Further explanation relative to the course pursued in regard to engines; less cost of the engines at Deptford than of the Cornish engines, 5825–5827——Probability of there being five or six more separate contracts to be let, instead of three more, 5827.

With regard to the rejection of Mr. Ridley's tender for the first section of the embankment and low level sewer, witness will submit to the Committee an explanation, in writing, of the part taken by him in the matter, 5827–5829.

Bazalgette, Mr. Explanation of the circumstances under which witness was to receive a commission of 12,000 *l.* from Mr. Furness, in connection with some works at Odessa; this matter did not in any way effect his relations with Mr. Furness as contractor under the Metropolitan Board, *Bazalgette* 5259–5266. 5290–5294.

Reference to the Report by a committee of the Board disapproving of the conduct of Mr. Bazalgette in the Odessa affair; this was subsequent to the acceptance of the tender

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of Mr. Furness for the first section of the Thames embankment, &c., or the tender would never have been accepted, *Roche* 5630-5645—— Genuine character of the investigation by the Board into the part taken by Mr. Bazalgette in the matter of the Odessa contract, *ib.* 5646.

Great arbitrary power of the engineer under the present system of contracts, in the absence of an arbitration clause; *Roche* 5672. 5679. 5683, 5684, *Nicholay* 5775.

Statement relative to the implication of Mr. Bazalgette in the affair of the Odessa contract; circumstance of this not having been made public at the time of the acceptance of Mr. Furness's contract in lieu of Mr. Ridley's, *Nicholay* 5740-5748.

Report of the Board dated 25 November 1863, upon the course pursued by Mr. Bazalgette in connection with the Odessa contract, and with the contract of Mr. Furness for portion of the Thames embankment, *App.* 499-501.

Letter from Mr. Bazalgette to the Committee, dated 4 July 1864, in refutation of certain evidence relative to the Northern Outfall Reservoir, in explanation of the provision made for extra work under the several contracts, and of the course pursued in regard to the material used in the formation of the Thames embankment, *App.* 497-499.

Statement submitted to the Metropolitan Board of Works by Mr. Bazalgette, dated 24 November 1863, in explanation of the part taken by him, in conjunction with Sir John Rennie, with reference to the receipt of a commission from Mr. Furness upon the sale to him of the concession for the construction of works at Odessa, *App.* 501, 502 —— Explanation in the foregoing statement with reference to the contract of Mr. Furness for the Thames embankment; justification by Mr. Bazalgette of his own action in the matter, *ib.*

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Bermondsey Branch Sewer (Main Drainage). Explanation as to the acceptance of the tender of Messrs. Aird & Sons for the Bermondsey Branch Sewer, in lieu of the lower tenders of Messrs. Peto & Betts, and of Mr. Moxon, *Thwaites* 5836-5843——Messrs. Peto & Betts withdrew their tender, *ib.* 5836, 5837——Grounds for concluding that Mr. Moxon was not in a condition efficiently to carry out the works, *ib.* 5838-5843.

List of the names of the contractors who tendered for the work, and of the amounts of the several tenders, with the names of the sureties proposed, *App.* 483——Further statement showing the tender accepted, the amount thereof, and the names of the sureties accepted, *ib.* 487——Returns showing the time when the contract was entered into, when the works were to have been completed, and when they were actually finished and delivered to the Board; also the amount actually paid on the contract, including extra work, *ib.* 489, 490——Amount of provision made for extra works, &c., *ib.* 494-496.

Bermondsey Vestry. Resolution adopted by the vestry, in March 1863, as to the expediency of the Metropolitan Board not granting any hasty concession of the sewage, on account of its probable value to the ratepayers, *App.* 447.

Birmingham. Silting up of the streams near Birmingham from various causes, including sewage discharges; injurious floodings thereby, *Rawlinson* 4007, 4008. 4150.

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Bishopsgate Ward Ratepayers' Association. Resolutions adopted by the association on 9th December 1863 with reference to the economic and profitable utilisation of the metropolitan sewage, *App.* 449, 450. 452.

Board of Works. See *Metropolitan Board of Works.*

Boards of Guardians. Responsibility of the board of guardians, in failure of any other local authority, for the removal of nuisances, *Taylor* 3942, 3943. 3979.

Booth, Mr. Communication from Mr. Booth to the Board of Works, dated 14 July 1863, with reference to a plan for the utilisation of the sewage of the metropolis, *App.* 439, 440.

Bowing, John. See *Ellis, Thomas, &c.*

Bradford. Very foul state of the canal at Bradford, *Rawlinson* 4113-4115.

Bridgwater Canal. Offensive state of the Bridgwater Canal, which is chiefly supplied from the river Medlock, *Rawlinson* 4058-4060. 4064.

Brunlees, James. See *Roberts, Charles Henry Compton, &c.*

Burnley. Burnley was at one time nearly as bad as Keighley as regards the stoppage of the drains by the filling up of the stream, but the local authorities have, within the last few years, applied protective measures, *Craven* 4294.

Buxton. Pure state of the river Wye after receiving the sewage of Buxton, where the sewerage was executed by witness, *Rawlinson* 4156-4158.

C.

Caird, Mr. (Member of the Committee.)—Opinion expressed by Mr. Caird that 30,000 or 40,000 acres would be sufficient for the utilisation of the London sewage, *Sir C. Fox* 1290.

Campbell, Mr. (Rugby). Statement as to Mr. Campbell having learnt much from the sewage experiments at Rugby, *Lawes* 4419–4421——Mr. Campbell has abandoned the practice of sewage application to an extended area, *ib.* 4651——Reference to the views of Mr. Campbell of Rugby as to the value of sewage application to grass land; dissent therefrom, *Congreve* 5017–5021.

Capital (*Utilisation of Sewage*). Statement that it would never pay to raise a capital of several millions in order to utilise the metropolitan sewage, or to give a large rent for the sewage; results of experiments elsewhere adverted to hereon, *Rawlinson* 4133. 4227–4247.

See also *London and Provincial Sewage Company. London and Provincial Towns.*
Sewage Irrigation Company, 8. *London Sewage Utilisation Company.*
M‘Clean, John R. Metropolis Sewage and Essex Reclamation Company.
Pipes and Mains. Pumping or Lifting, &c. Torrington, Lord, and others, 5.

Carlisle. The best application of sewage that witness has seen is that at Carlisle by Dr. Angus Smith, *Bateman* 2666, 2667.

Cassiobury Park. See *Essex, Earl of.*

Catchment Basins of Rivers. See *Watershed Boards.*

Cattle. Several instances of the injurious effect upon cattle where town sewage flows into rivers used by the cattle, *Whitehead* 2708. 2717–2727. 2806–2808. 2844–2848——Doubt as to sewage grass being good for fattening cattle, *Lawes* 4327–4332. 4469. 4550–4551——Testimony borne by the Earl of Essex to the fattening properties of sewage rye grass, *App.* 345.

Cereal Crops. See *Wheat.*

Cesspools. Very recent date down to which communication was restricted between the cesspools and the street sewers in the metropolis, *Gael* 3062–3078——Nature of the arrangements for emptying the cesspools and removing the contents, prior to their being allowed to be flushed into the sewers, *ib.* 3062–3064, 3077. 3084–3092——Restrictions under the common law in regard to the emptying of the cesspools into the sewers, and conclusions as to the illegality of the practice at the present time, *ib.* 3070, 3071. 3079–3083. 3092 *et seq.*—— Authority given eventually by the Commissioners of Sewers to the practice of discharging the house refuse into the sewers; reasons for this course of proceeding on their part though a contravention of the common law, *ib.* 3078–3083. 3099. 3136–3144.

The refuse used formerly to be removed into the country in vegetable carts, &c., and applied as a manure, *Gael* 3090, 3091——Sense in which the legislature may be said to have legalised the practice of discharging the cesspools, &c. into the sewers and the rivers, although the practice is strictly contrary to law, *ib.* 3141. 3159. 3252–3255——Practice at present in the outskirts of London in regard to the removal of house refuse, where there are no connecting drains, *ib.* 3230–3234.

Probability of an improved arrangement of cesspools being feasible, whereby the evils of the former imperfect system might be obviated, *Acland* 3599, 3600.

Notion entertained by the former Commissioners of Sewers that the refuse from the houses should in time be excluded from the river and utilised, *Taylor* 3846——General abandonment of cesspools since the year 1840, the drainage of towns being now greatly improved, and the house refuse being discharged into sewers, *ib.* 3847–3852——Doubt whether cesspools can be arranged on an improved and unobjectionable system for utilising the excrements, *ib.* 3944, 3945.

The refuse used not formerly always to be applied to land, *Rawlinson* 4011, 4012——Any scheme for removing the fœcal matter from each house in London would be utterly inapplicable, *ib.* 4176–4178——On the score of health, witness would greatly regret any return to the cesspool system, *ib.* 4178. 4184–4187. 4217—— Advantages of the system at Croydon as compared with the cesspool system at Manchester for dealing with the sewage, *ib.* 4191–4196——Much less danger to health where the cesspools are constantly uncovered than where they are covered or attempted to be hermetically sealed, *ib.* 4219–4222.

Obstructions formerly thrown in the way of house drains, which should empty themselves into the street sewers, *Rep.* vi—— Explanation as to steps not having been taken in order to prevent the refuse of houses being flushed into the sewers, *ib.*——Increased pollution of the river in proportion as there is a more perfect system of house drainage, *ib.*——Reference to the practice until within the last thirty years of utilising all the nightsoil and other refuse on the land; abandonment of the practice when the modern water-closets came into vogue, *ib.*

See also *Eureka Company. Manchester. Sewers. Water Closets.*

Chelmsford. Practice at Chelmsford of disposing separately of the solid portion of the sewage, *Taylor* 3894.

Chemical Ingredients of Sewage. See *Value of Sewage.*

Cholera. Statements as to cholera being attributable to causes within the four walls of each house rather than to anything external, such as polluted rivers, *Rawlinson* 4118. 4223-4226.

Clay Soils. Way in which clay soils operate in abstracting the manurial properties from sewage; less effectual action of sandy soils, *Way* 4728-4734. 4739, 4740——Unsuitableness of a stiff clay soil for the absorption of sewage in large quantities, *ib.* 4863, 4864. 4933.

Cleaver, Joseph. See *M'Cormick, William, &c.*

Clipstone Park. Instance at Clipstone Park of the valuable effect of sewage after it had passed through one estate on to another, *Smith* 1533. 1593.

Clyde, The. Especially polluted and offensive condition of the Clyde, *Rawlinson* 4067. 4068.

Cochrane, A. Letter from Mr. Cochrane to the Metropolitan Board of Works, dated 26 June 1863, submitting a proposition for utilising the sewage of the metropolis, *App.* 439.

Commission of Inquiry (*State of the Thames*). Memorial in May 1862, soliciitng the appointment of a Commission of Inquiry for investigating and reporting upon the condition of the Thames and of its tributaries, *App.* 272, 273.

Commissioners of Sewers. See *Cesspools.* *Sewers.*

Compulsory Enactment. See *Legislation.* *Local Boards.* *Rivers and Streams,* 2. *Thames The,* 3.

Congreve, Samuel Bury. (Analysis of his Evidence.)—Is a tenant farmer near Rugby, and is well conversant with the sewage experiments of Mr. Walker and Mr. Lawes, 5007-5013. 5050-5052——Considers that though larger grass crops were produced at Rugby by Mr. Lawes, the crops are much worse in quality, and the land is greatly injured, 5014 *et seq.*——Reference to the views of Mr. Campbell, of Rugby, as to the value of sewage applications to grass land; dissent therefrom, 5017-5021——Improved state of the land when Mr. Lawes began his experiments, so that the crops are not due entirely to the sewage, 5027——Inferior character of the land since the sewage applications as compared with unsewaged land, 5028-5030. 5045. 5054-5070.

Amount of the water supply of Rugby and of the population; varying character of the sewage, 5031-5042——Usefulness of sewage as applied to poor grass land, but not to arable land, 5047-5049. 5061-5065——Deterioration in the quality of the grasses by the application of sewage further adverted to; all the finer grasses are in fact destroyed, 5053. 5056. 5068-5091——Witness would rather not have any sewage if required to take it at all times, 5057-5062——When applied by Mr. Campbell to rye-grass, sewage has not produced a great result, and has greatly injured the land, 5092, 5093——Explanation of the circumstances under which witness gave up the land formerly held by him, and subjected to the sewage experiments, 5094-5104.

Contracts (*Metropolitan Board*). Practice of the Metropolitan Board usually to accept the lowest tenders for contracts, *Roche* 5614; *Nicholay* 5730——The absence of an arbitration clause excludes tenders from many eligible contractors, and interferes with a really open competition, *Roche* 5672-5674. 5678-5681. 5693-5698. 5705. 5712-5715; *Nicholay* 5767-5769. 5774-5777. 5820——Altered practice in regard to the reading of the engineers' estimates, they not being now made known until the tenders are opened, *Roche* 5726——System of the Board to have an open and advertised competition, rather than a limited competition among contractors previously ascertained to be competent, *Nicholay* 5809-5819.

Explanations relative to several instances of non-acceptance by the Board, of the lowest tenders or contracts for portions of the main drainage scheme, *Thwaites* 5836 *et seq.*——Information on the subject of penalties, and their non-enforcement in the case of contracts for the Main Drainage Works, *ib.* 5871-5875.

List of tenders for the several sewers, &c., comprised in the Main Drainage Works, showing the amount, and the tenders or contracts accepted, *App.* 479-488——Return showing the time when each contract for the Main Drainage Works was entered into, and when the works under that contract were to have been completed; also the time when the works were actually finished and delivered to the Board, with other particulars, *ib.* 489, 490.

Paper submitted by the Chairman of the Metropolitan Board, containing particulars explanatory of the contracts completed, and of the contracts in progress, in the case of the Main Drainage, *App.* 494, 495.

See also *Advertisements.* *Main Drainage Works.* *Northern Outfall Reservoir.* *Tenders.* *Thames Embankment, &c.*

Conveyance of Sewage. Doubt as to there being much loss or deterioration over fifteen miles of carriage in the proposed culvert from Barking to the Maplin Sands, *Hemans* 830-833——Almost equal value of the sewage at a distance from the outfall as near to the outfall, *Smith* 1522.

Witness considers that the sewage may, with a good profit, be delivered on farms to a distance of 100 miles round London, at one-fourth the cost of guano, or one halfpenny per ton, *Shepherd* 1611–1616. 1691-1697——Greater economy in conveying the liquid sewage than in the carriage of the extracted matter in a solid state, *Ellis* 1802–1808——Opinion as to the equal value of the sewage at a distance from London and in the vicinity of London, *ib.* 2015–2018.

Statement as to the facility and great economy of carrying clay through the medium of water, by gravitation; inference as to the facility of a similar conveyance of the London sewage, *West* 2163–2174. 2178–2181——Sewage would not be deteriorated by being conveyed forty miles from London, but the expense would probably prevent its carriage to such a distance, *Way* 4888, 4889.

Reference by the Committee to the facility of a much easier and cheaper removal of house refuse to the land than formerly, *Rep.* vi——Carriage by suspension in a liquid is the cheapest mode of transport of house sewage, *ib.*

See also *Culverts. Earthenware Pipes. Gravitation. Open Conduits. Pipes and Mains. Vicinity of Towns.*

Cornish Engines. See *Engines.*

Corporations. Conditions under which corporations, as distinct from local Boards, may exercise extended powers for carrying out sewage utilisation works, *Taylor* 3918-3925.

Cost of Application to Land. See *Agriculture,* 6. *Conveyance of Sewage. Croydon,* 3, 4. *Engines. Gravitation. Hose and Jet. Open Gutters. Pipes and Mains. Pumping or Lifting, &c.*

Coventry. Works about to be commenced by witness at Coventry, where he states he has got a conditional concession of the sewage; reference hereon to a recent communication from the Town Clerk of Coventry to the Chairman of the Committee, in which it is denied that there is now any negotiation open with witness, *Shepherd* 1716–1725.

Proposition submitted to the Board by Mr. Shepherd in 1861 and 1862 for certain experiments at Coventry, if a concession of the London sewage be granted to him, *App.* 350. 352.

Craigentinny Meadows. See *Edinburgh.*

Craven, John. (Analysis of his Evidence.)—Manufacturer at Keighley, in Yorkshire, 4255, 4256. 4265——Statement relative to the gradual filling up of the River Worth and the North Beck, which run through the town of Keighley, on account of the discharge into them of engine ashes and other rubbish by the manufacturers, 4257–4261. 4266. 4274–4281——Effect of the filling up of the beds of the streams to stop up some of the drains, and dam back the drainage into the cellars: great nuisance and injury to health thereby, 4262, 4263. 4266–4273. 4286–4288.

Entire failure of repeated efforts to induce the Local Board of Health at Keighley to take measures for preventing the filling up of the streams, and the injurious effect upon the drainage, and upon health, 4264. 4269. 4293——Legal steps being taken by witness's firm, with a view to remedy the nuisance: probability of the litigation being very expensive to them, 4264, 4265. 4285. 4291, 4292——Circumstance of several members of the Local Board of Health being interested as manufacturers in filling up the streams, 4266. 4278–4285. 4289——Great advantage if there were some authority for compelling the Local Board to put the law in motion for the protection of the streams, 4289-4294.

Burnley was at one time nearly as bad as Keighley as regards the stoppage of the drains by the filling up of the stream, but the local authorities have within the last few years applied protective measures, 4294.

Crops. See *Agriculture. Grass Land. Italian Rye-grass. Wheat.*

Crossness Pumping Station (Main Drainage). The pumping station at Crossness will be completed in the autumn, *Bazalgette* 5135——Information relative to the cost and the working expenses of the engines at this station; they are being made by Messrs. Watt & Co., *ib.* 5196-5207.

Crouch River (Essex). Objection, as regards the River Crouch, to the sewage water being drained into the sea off the Maplin Sands, as under the scheme of Messrs. Napier & Hope, *Hopkins* 1047, 1048.

CROYDON:

1. *Legal Proceedings which led to the Utilisation of the Croydon Sewage.*
2. *Character or Quality of the Sewage.*
3. *System of Application to the Land.*
4. *Degree of Sucess attending the Application.*

1. *Legal Proceedings which led to the Utilisation of the Croydon Sewage:*

Information relative to several lawsuits and injunctions against the Local Board with reference to the pollution of the river; great expense thereby, prior to the adoption of measures for utilising the sewage on the land, *Johnson* 2222–2226. 2274–2276. 2351, 2389–2393——Reference to the injunctions obtained in the Croydon case, as having ultimately driven the local authorities to apply the sewage to the land, *Taylor* 3816–3821.

2. *Character or Quality of the Sewage:*

Population of from 15,000 to 20,000, whose sewage used to flow into the river at Croydon, the volume of the sewage being from 800,000 to 1,000,000 gallons per day, *Johnson* 2217–2219, 2322, 2322, 2348——Large proportion borne by the volume of the sewage to the River Wandle, *ib.* 2220, 2221——Character of the sewage of Croydon as compared with that of London, *ib.* 2305–2307. 2346–2350.

3. *System of Application to the Land:*

Application for several years past, of the sewage to grass lands, whence it flows almost quite pure into the river, *Johnson* 2226–2228. 2276–2280. 2319. 2327, 2328, 2331——Increased area over which the sewage is now applied, its having been found a nuisance when distributed over a small acreage; absence of any nuisance at present, *ib.* 2229–2238. 2317–2318. 2329, 2330——System of open carrier drains, whence the sewage flows on to the land; mode of forming these, *ib.* 2236. 2296–2302, 2342——Application daily of the total sewage to about thirty or forty acres, there being about 250 acres altogether, *ib.* 2239–2243.

Character of the works necessary, and amount of the expense incurred, in the conveyance and application of the sewage; absence of offensive smell from the settling tanks, which are uncovered, *Johnson* 2245–2260. 2403——Plan for removing the deposit from the tanks; small sum received for this, it not being of much value as a manure, *ib.* 2250–2255. 2270. 2272. 2295, 2296——Way in which the water, or sewage when pumped, flows into the Wandle, *ib.* 2260——Considerable difficulty experienced in the draining of Croydon, *ib.* 2353–2355——Difficulty at times in Mr. Marriage, the tenant of the sewaged land, using all the sewage, *ib.* 2363–2365.

Very exceptionable character of the arrangements at Croydon; great waste of sewage there on the part of the local authorities, *Ellis* 2465–2472——Difficulty of dealing with the Croydon sewage as compared with the London sewage, *Dales* 3762——Considerable saving of outlay if the works had now to be made for the first time, *Rawlinson* 4197, 4198. 4240, 4241.

4. *Degree of Success attending the Application:*

Great improvement of the lands at Croydon as irrigated by gravitation, *Hope* 875——Beneficial operation of the sewage upon grass land especially; several crops and large returns obtained, so that it must be very profitable to the farmer who uses it, *Johnson* 2236, 2237. 2244. 2309–2315. 2320, 2321. 2337–2341——Payment by Mr. Marriage, the farmer who takes the sewage, of a rent of 5 *l.* per acre for the sewaged land, the Local Board paying 4 *l.* an acre in the first instance, *ib.* 2265–2273. 2394. 2398.

Increased returns anticipated but for the contract by which the Local Board are bound to Mr. Marriage, *Johnson* 2272. 2338–2340. 2356–2363. 2397–2402——Large area to which the sewage might be applied with advantage; quantity desirable to be applied per acre adverted to herein, *ib.* 2281–2295. 2305–2308. 2322–2325. 2332–2336. 2363——Increased crops of Italian rye-grass and of natural grass, by the application, at Croydon, *ib.* 2344, 2345.

Reference to the very large profit received by Mr. Marriage from renting sewaged land at 5 *l.* an acre, *Mechi* 3352——Remarks relative to the application of sewage at Croydon, the quantity of land to which applied, the cost incurred, &c.; comparative success of the experiment, *Rawlinson* 4089–4093. 4107. 4146–4149. 4163, 4164. 4240–4242.

Croydon Sewage Irrigation Company. Explanation relative to the failure of the Croydon Sewage Irrigation Company, to which witness was engineer, *Shepherd* 1701–1707——The scheme failed for want of support, having been brought out in a peculiarly bad harvest year, *ib.* 1701. 1704. 1707——Baron Liebig had accepted the appointment of consulting chemist to the scheme, *ib.* 1702.

Proposal by Mr. Shepherd, in 1860, for experiments at Croydon by means of this Company, that is, in conjunction with his application for a concession of the London sewage, *App.* 342.

Prospectus

Croydon Sewage Irrigation Company—continued.

Prospectus of the Company in 1860; sundry details therein as to the mode in which it is proposed to deal with the sewage of Croydon, the cost of the works, the revenue to be derived, &c., *App.* 343, 344.

Culverts (*Conveyance of Sewage*). Statement as to the advantage of stone or brick culverts for the conveyance of sewage, as well as of water, *Bateman* 2621-2626. 2643-2647. 2677, 2678——Non-objection to culverts on the score of friction, *ib.* 2685, 2686——Form or shape of culvert desirable for the conveyance of sewage, *ib.* 2688-2691.

Statement explanatory of the cost of brick culverts, as compared with the cost of iron pipes, *App.* 281. *See* also *Metropolis Sewage and Essex Reclamation Company*, 2.

Curwood, David. Suggestions for dealing with the sewage were made by Mr. David Curwood, but no tender or plan was submitted, *Thwaites* 182, 183.

Letter from Mr. Curwood to the Metropolitan Board of Works dated 7 May 1863, proposing to utilise the sewage by converting the thick and heavy material into a solid manure, and by using the thin part of the sewage upon the lands adjoining the banks of the river, *App.* 315.

D

Dales, John. (Analysis of his Evidence).—Engineer and contractor, 3739-3742——Invented a process for deodorising sewage, which has been favourably reported upon by Drs. Hofmann and Frankland, 3743-3745——Considers that, save under exceptional circumstances, sewage need not be deodorised if applied to land, 3746-3749——Limit to the power of the earth to extract the fertilising matters from the sewage, so that waste ensues if more than a certain quantity be applied, 3750-3753.

With regard to the sewage of Alnwick not having been utilised by the farmers, though given great facilities by the Duke of Northumberland, witness explains that it is of a very poor character, 3754-3756——Statement as to the use for some time of witness's deodorising process by the Croydon Local Board, 3757-3762——Difficulty of dealing with the Croydon sewage, as compared with the London sewage, 3762

Information relative to a former application by witness of sewage to wheat land, and the very successful effect thereof over a course of years, 3763-3791——Willingness of farmers to pay a moderate price for town sewage, 3769——Beneficial effect of sewage upon the growth of potatoes, peas, &c. 3792, 3793——Less retention of liquid manures by sandy soils than by other soils, good soils being very retentive of them, 3794-3796.

Dengie Flats. See *Metropolis Sewage and Essex Reclamation Company.*

Deodorisation. Expediency not only of underground drainage but of deodorisation, in the application of the sewage; how this process should be carried out, *Smith* 1525-1527. 1555-1561——Opinion as to sulphate of ammonia being the best deodorant, *ib.* 1527-1565——Material improvement by deodorisation in the manurial value of the liquid sewage, *ib.* 1557-1561.

Absence of any necessity for deodorising the sewage before distribution, *Ellis* 1921, 1922——Conclusion as to the land acting as an excellent deodoriser upon sewage matter, *Whitehead* 2830-2834.

Witness invented a process for deodorising sewage, which has been favourably reported upon by Drs. Hofmann and Frankland, *Dales* 3743-3745——Considers that, save under exceptional circumstances, sewage need not be deodorised if applied to land, *ib.* 3746-3749——The earth is a great deodoriser, *ib.* 3749——Statement as to the use for some time of witness's deodorising process by the Croydon Local Board, *ib.* 3757-3762.

Mistake in deodorising sewage applied to land, the land itself being the best deodoriser, *Way* 4726, 4727.

Papers explanatory of the scheme of Mr. Kirkman for deodorising the sewage, and utilising it in a solid form, *App.* 354-361.

See also *Kirkman, C. F.* *Lime Process.* *Solid Manure.*

Deptford Pumping Station (*Main Drainage*). The pumping station at Deptford is not yet complete, but is in working, *Bazalgette* 5135——Reasons for the rejection of Mr. Strap's tender for works at the Deptford pumping station, though lower than the accepted tender of Messrs. Aird & Sons, *Thwaites* 5859, 5860.

List of the names of the contractors who tendered for the work, and of the amounts of their several tenders, with the names of the sureties proposed, *App.* 482——Further statement showing the tender accepted, the amount thereof, and the names of the sureties accepted, *ib.* 487——Returns showing the time when the contract was entered into, when the works were to have been completed, and when they were actually finished and delivered to the Board; also the amount actually paid on the contract, including extra work, *ib.* 489, 490——Statement of the provision made for extra works, &c., *ib.* 494-496.

Deviations (*Line of Sewers*). Practice as regards addition to or deduction from the contract price when deviations are made in the line of any of the Main Drainage Sewers, as in the Low Level Sewer on the south side, *Ridley* 5495–5502——Practice also as to contractors for the sewers paying for severance of property and right of way, and as to the saving by deviation on to the high road, *ib.* 5603–5612.

See also *Southern Low Level Sewer.*

Discharge of Sewage (*Barking*). Dissent from the view that the sewage, if discharged at Barking would flow up to London, *Bazalgette* 382——Statement as regards the discharge of the London sewage at Barking that it finds its way down the river only one mile in twenty-four hours, *Rawlinson* 4036–4038——Belief that the London Sewage, if discharged at Barking, will partly return to London, *Lawes* 4386–4388.

Disinfectants. Facility of entirely preventing any offensive smell in the application of the sewage to land by the use of a disinfectant, *Rawlinson* 4208–4215——Great cheapness of disinfectants, *ib.* 4210. 4212, 4213——Effectual character of the disinfecting fluid patented by Mr. M'Dougall; its cheapness, *ib.* 4211–4213.

Distribution of Sewage (*Agriculture*). See *Gravitation. Hose and Jet. Open Gutters. Pipes and Mains.*

District Reservoirs. Under witness's scheme, proposed in 1857, for dealing with the metropolitan sewage, a system of district reservoirs was to be in connexion with two high level reservoirs, and the sewage was to be distributed over certain areas around each district reservoir, *Shepherd* 1622–1640.

Dorchester. Very foul state of the River Frome, into which the Dorchester sewage flows, *Whitehead* 2789–2797.

Drainage of Land. Importance of attending to the aëration of the soil in carrying out the drainage of land; defect of witness's system of drainage in this respect, *Mechi* 3429–3431. 3433–3435. 3442.

Drainage of Towns. See *Cesspools. Sewers. Water Closets.*

Dry or Solid Manure. See *Solid Manure.*

E.

Earthenware Pipes. Calculated use of 1,309 miles of earthenware pipes, in addition to the mains, under the scheme of Lord Torrington and others for distributing the sewage of the metropolis, *Smith* 1338——Efficiency of the plan proposed for jointing the earthenware pipes, under the scheme advocated by witness, *Sir C. Fox* 1482–1484.

Earthenware pipes on a large scale would not be suitable, *Bateman* 2625——Non-objection to earthenware pipes as subsidiary distributing pipes, *ib.* 2658, 2659.

Edinburgh (*Craigentinny Meadows*). Very large rental yielded by the Craigentinny meadows, to which the sewage of Edinburgh is applied, *Hemans* 629. 633–638——Circumstance of the farmers not paying anything for the sewage passing through Craigentinny meadows, the ratepayers being glad to get rid of it, *Hope* 757–760, 780–782. 864–866——Slight amount of the deposit left upon the surface lands at Edinburgh, *ib.* 764——Very clumsy character of the system of distribution, *ib.* 880. 910.

Very slow increase of deposit or soil in the case of the sewaged land at Edinburgh, *Hopkins* 1044——Value of the produce of the Edinbugh meadows adverted to as being computed upon the imperial acre, *Smith* 1574–1577.

Long experience in the application of sewage to land at Edinburgh, without any injury to health having been experienced, *Rawlinson* 4103, 4104——Cause of the offensive smell from the open carriers for distributing the Edinburgh sewage, *ib.* 4104. 4252–4254——Success of the Edinburgh application of sewage in an agricultural sense, *ib.* 4130–4133.

It pays to give 30 *l.* or 40 *l.* an acre on account of the large crops, *Lawes* 4581——Wasteful use of the sewage as applied to the meadows, on account of the defective system of application, and the quantity applied, *Lawes* 4692–4697; *Way* 4971–4975.

Edinburgh Sewerage. Very injurious system of sewerage at Edinburgh, the noxious gasses being conducted back into the houses, *Rawlinson* 4225, 4226.

Ellis, Thomas, and John Bowing. (Analysis of their Evidence).—(*Mr. Ellis*) Is by profession a solicitor, but has not practised for many years; was never struck off the rolls, 1726——Proposes to distribute the sewage of London over an area of 500,000 acres, 1727——The sewage would be retailed entirely to farmers, 1728——Without an accurate survey of the area taken it is difficult to state the capital necessary, but witness estimates that 4,000,000 *l* will be ample for the works, 1729, 1730.

Witness is conversant with agriculture, but bases his scheme not upon any experience of his own relative to town sewage, but upon results well authenticated by others, and more

Ellis, Thomas, and John Bowing. (Analysis of their Evidence)—*continued.*

more especially upon the analysis and calculations made by Messrs. Hofmann and Witt, 1732–1743——Calculation by Messrs. Hofmann and Witt, that in 1250 tons of sewage there is as much fertilising matter, if extracted and dried, as in one ton of guano, the value of the sewage being at this rate about 2 *d.* per ton, 1736–1743——Information as to the total quantity of the sewage from the north and south side, as estimated by Messrs. Hofmann and Witt, by Mr. Bazalgette, and by witness, respectively 1739–1764.

Grounds for concluding that the sewage in wet weather, or the storm sewage, is much richer in manurial properties than the dry-weather sewage, 1741, 1742——Calculations as to the value of the total annual sewage of the north and south side respectively, with reference, that is, to the price of guano at 11 *l.* per ton and the present price of guano; difficulty hereon in estimating the aggregate quantity, 1744–1771——Witness assumes an aggregate quantity less than is assumed by Messrs. Hofmann and Witt, or by Mr. Bazalgette, and places the value at 2,341,262 *l.*, or, taking the present price of guano as a basis, at 2,793,551 *l.* 5 *s.*, 1763–1767.

Total of 266,052,441 tons estimated by witness, 1764——Taking the north side sewage at 168,033,115 tons per annum, 336,066 acres might be irrigated at the rate of 500 tons per acre yearly, 1768, 1769——The above quantity would contain an equivalent of 134,424 tons of guano, which at present value would represent 1,764,345 *l.* 5 *s.*, 1770, 1771.

Reference to a statement by Messrs. Napier and Hope, based upon the assumption that the London sewage is theoretically worth 6 *s.* per head of the population per annum; data for assuming rather that the annual value of the excreta alone is 10 *s.* 10 *d.* per head, 1772–1780——Immense value represented by the sewage of Great Britain and Ireland if it could be utilised; amount of the taxation of the country adverted to hereon, 1781–1784——Value of 4 *l.* 8 *s.* per 500 tons of sewage if the manurial constituents could be extracted and dried, 1785–1788.

Proposed use of the sewage in addition to other manures, farmyard manure, &c., being still used as well as sewage, 1789, 1790——Inaccuracy of the view that grass land will give returns in proportion to the quantity of sewage applied, 1790. 1816–1822——Conclusion as to sewage being equally applicable to other crops as well as to grass, 1790. 1794, 1795——Calculation that an average supply of 500 tons per acre yearly, though not so much as could be applied beneficially, is as much as could be sold to the farmers with advantage to the Company, 1790–1793——With regard to a reported statement by Professor Way that sewage manure is of no value until it is extracted and dried, this conclusion is altogether erroneous, 1796–1801.

Witness contends that the effect of sewage in a liquid state is unquestionably greater than when the manure is extracted and dried, 1797–1801. 1804——Greater economy in conveying the liquid sewage than in the carriage of the extracted matter in a solid state, 1802–1808——Increased value of the sewage if there were phosphates in it; this matter would rest with the chemist of the Company, 1809–1811. 1988, 1989. 2038.

Profitable results obtained by farmers from the use of a moderate amount of sewage, 1812, 1813——Grounds for condemning as entirely wrong the views of Mr. Lawes in regard to the produce on certain lands being in direct proportion to the quantity of sewage applied, 1814–1823——Instance of the beneficial effect of a small application of sewage to wheat land, 1823.

Explanation as to the proposed works extending over 1,075,200 acres, 1824–1828——The cost of the works will probably not be more than 3,500,000 *l.*, 1829. 1996——Prospect of the ratepayers receiving a profit of more than 700,000 *l.* a year, 1830——Particulars in connection with the supply of sewage received into the outfall tanks of the Metropolitan Board, and the arrangements under witness's scheme for pumping from the outfall to reservoirs at Hampstead-hill and Shooters-hill, 1831–1861.

(*Mr. Bowing.*) Information relative to the length, size, and cost of the proposed mains for conveying the sewage from the outfall to the high-level reservoirs, 1862–1872——Twofold size of the reservoirs as compared with the outfall tanks; object thereof, 1873–1878——Probable shape, mode of construction, and area of the reservoirs; question as the sufficiency of the estimated cost adverted to hereon, 1879–1890——Explanation as to the proposed area of distribution on the south side and north side respectively, 1892–1896.

Rate of fall of the sewage from the reservoirs through the distributing mains, 1897——The mains are laid below ground, 1898——There is on an average one mile of main to each square mile of country, 1900——Division of the area into concentric circles, there being different sizes of mains for the different areas, 1901. 1908——Total of 4,053,331 *l.* as the cost of all the distributing mains, including the laying, 1909–1912.

(*Mr. Ellis.*) It is proposed to follow the practice of the water companies, and to allow the farmers to lay down the pipes and distribute as they please, the sewage being supplied from the main by meter, 1913–1917. 2013. 2019.——(*Mr. Bowing.*) Estimate of 332,125 *l.* as the total annual working expenses, 1918–1920.——(*Mr. Ellis.*) Absence

Ellis, Thomas, and John Bowing. (Analysis of their Evidence)—*continued.*

of any necessity for deodorising the sewage before distribution, 1921, 1922.——(*Mr. Bowring.*) Aggregate outlay of 5,868,662 *l.* if the works be carried out on a certain scale; opinion that this is greatly in excess of what is required, 1923. 1926——Estimated net annual profit of 1,884,979 *l.*, one-half of which would go to the ratepayers, 1926, 1927.

(*Mr. Ellis.*) Advantage of a large area as enhancing the price to be obtained for the sewage, 1928. 2046, 2047 ——Obstacle to applying the sewage during frost; it should then be deodorised and let run into the river, 1929–1931 ——Anticipated demand for the sewage by the farmers, otherwise the project would be a failure, 1932. 1995. 2000, 2001——Witness has not altered his plans since his first tender, except that he now offers more favourable terms to the ratepayers, 1933, 1934.

Statement as to the Board of Works having on 16 November 1861 applied to witness for details of his plans which it would have cost him some 130,000 *l.* to supply; copy of this application, 1935–1937. 1947–1951——Complaint as to the foregoing application having been made to witness some days after the Main Drainage Committee of the Board had directed Mr. Bazalgette to report upon the scheme of Messrs. Napier and Hope, 1938. 1945–1958.

Inability of witness to raise the required capital if a fixed annual rent were demanded by the Board, or if a royalty per ton were required, 1939, 1940——Inaccuracy of a statement that witness had demanded a preferential dividend of twenty per cent. for the Company, 1941, 1942——Witness and the other promoters of the scheme are prepared to lodge a sum of 60,000 *l.* for preliminary expenses, and are desirous of being prevented from raising any of the capital until they have obtained an Act, 1943. 1944. 2034–2037. 2072–2079. 2120, 2121.

Statement as to the scheme of Messrs. Napier and Hope having come to nothing because of their inability to procure the required Parliamentary deposit for their Bill, and because of the appointment of a Select Committee to inquire into the whole subject, 1959, 1960——Protest made by witness against publicity being given to his examination before the Board of Works in February last; complaint more especially that his evidence was falsified, and an incorrect report printed, 1961–1987.

Further statement that the earth will not absorb more than a limited quantity of liquid manure, 1990–1992——Confidence felt by witness in regard to procuring through a Company the required capital, 1993–1996——At present he asks only for a conditional arrangement to be turned into a concession of the sewage when an Act has been obtained, a Company formed, and the necessary capital raised; two years would suffice for this being done, 1996–1999. 2120. 2126–2128.

Witness further states that he has never made any experiments with town sewage as applied to agriculture; his experience as an agriculturist further adverted to, 2002–2005. 2132–2137——Further reference to the good commercial results obtained where small quantities of sewage have been applied, 2004, 2005——Limited amount of deposit which witness expects to have to deal with after receiving the sewage from the Board of Works, 2006–2011——Depth below the surface at which it is proposed to take the mains, 2012. 2023.

Proposed equal charge for the sewage wherever distributed, 2014——Opinion as to the equal value of the sewage at a distance from London and in the vicinity of London, 2015–2018——Improbability of any nuisance from the sewage if applied by the farmers on the surface, 2020–2022——Necessity of about three years for carrying out the works after the Act has been obtained, 2024–2029——Further reference to the amount of difficulty in applying the sewage during frost, 2030–2033.

Calculation as to the amount of profit to be obtained if the farmers will pay 1 *d.* per ton for the sewage, 2039–2046——The profit is larger or smaller according to the less or greater height to which the sewage must be lifted, 2044, 2045——Probability of the farmers readily paying 1 *d.* per ton for a limited quantity, but not 2 *d.* per ton, 2046, 2047——Greater loss of manurial properties of the sewage in sandy soils than in good soils, 2048–2050. 2131——Conclusion as to the unsuccessful character of the experiments of Mr. Lawes at Rugby, where very large quantities were applied, 2051, 2052——Very small amount applied advantageously by Mr. Mechi, 2053.

Further explanations relative to the arrangements for conveying the sewage from the outfall to the high-level reservoirs, 2054–2059——The reservoirs will not be placed in any spot of which the Board of Works disapprove, other sites besides Hampstead-hill and Shooters-hill being available, 2060, 1061. 2100–2104——Means of removing any residuum in the reservoirs, 2062, 2063——Way in which the sewage may be got rid of if the farmers will not pay for it; witness has no apprehension on the latter score, 2064–2066. 2087–2092——Reference to the question as to maps and sections having been furnished by Messrs. Napier and Hope; alteration in their original plans adverted to hereon, 2067–2071.

Intended laying of the pipes or mains along the roads, 2083——Further reference to the great expense of detailed surveys, &c., asked for by the Board, 2084–2086——Probable

Ellis, Thomas, and John Bowing. (Analysis of their Evidence)—*continued.*
bable explanation as to some sewage-pumping works erected by the Duke of Northumberland having never been made use of by the local farmers, though asked to pay merely for the expense of pumping, 2089-2092——Sufficient size of the proposed reservoirs for dealing with the sewage as computed by Mr. Bazalgette, 2093-2098——It will cost a little more than one farthing a ton to pump the sewage 460 feet, 2099. 2110.

Reference to the expressed feeling of the ratepayers in favour of witness's scheme, 2104, 2105——Fraud upon the ratepayers if witness were to guarantee them merely a limited rent, on account of the great value of the sewage and the large returns expected by him, 2106-2108. 2123-2125——Extent to which witness has had the advice of engineers as to the practicability of his plan, the cost of pumping, system of distributing pipes, &c., 2109-2120——Advantage if the sewage could be applied to an area equal in extent to half a county, 2129, 2130.

Second Examination.] (*Mr. Ellis.*)—Impracticability of extracting from the sewage all the manurial property, and drying it, so that its value in a solid shape is quite theoretical, 2412-2414——Further statement as to the sewage being of very much greater value as a manure when applied in a liquid than in a solid state, 2415, 2416——Interest of dealers in artificial manure to depreciate the value of town sewage, 2417, 2418. 2539-2542——Reference to a statement by Professor Way as to the importance of extracting and drying the fertilising substance in the sewage, 2419-2421——Explanation as to the authority upon which witness condemns the conclusions of Mr. Lawes as altogether unreliable, 2422-2426.

Further citation of the authority of Professor Way as showing that sewage applied beyond a certain limit is valueless, 2427-2429——There have been in fact several experiments conclusive as to the limited absorption of fertilising matter per acre, 2430, 2431. 2463——Opinion that on an average a smaller quantity than 500 tons per annum is as much as can be disposed of to farmers at the rate of 2 *d.* per ton, 2432-2442. 2510, 2511. 2532——Large application desirable in the case of Italian rye-grass, 2434-2436.

Witness further explains that his company proposes to lay down merely the mains along the roads; the field pipes to be laid down at the expense of the farmers or landlords, 2443. 2569——Information as to the probable cost per acre of the sub-mains or distributing apparatus to be supplied by the farmers; probable aggregate expenditure of 2,000,000 *l.* for this purpose, 2444-2457——Great expense of application by open carriers or gutters, 2449——Expense of application by hose or jet, which is the plan recommended by witness, 2450-2454.

Impracticability of procuring, by lease or purchase, an area sufficient for profitable utilisation of the sewage, whereas under witness's scheme this difficulty does not arise, 2458, 2459——Further examination in support of the conclusion that sewage can most advantageously be supplied in small quantities, 2460-2478——Comment upon the fact of Mr. Lawes being entrusted with the experiments about town sewage, he being so deeply interested in artificial manures, 2463.

Very exceptionable character of the arrangements at Croydon; great waste of sewage there on the part of the local authorities, 2465-2472——Wasteful expenditure if guano were applied in large quantities to arable land, 2472-2474——Inference as to large applications of sewage to grass land not having proved successful in the case of Lord Essex, 2475-2478. 2580.

Further explanations on the subject of the proposed summit reservoirs, their site, mode of construction, &c., 2479-2489. 2516. 2581, 2582——Statement in further support of the conclusion that farmers would pay a fair price for the sewage, 2490-2495——Authority for former statement as to Messrs. Napier & Hope having vainly endeavoured to raise the deposit money for their plan, 2496, 2497——Nature of the experience of witness further adverted to; he was specially educated with regard to agriculture, 2498-2506——Letter from a master in chancery in Ireland, showing that witness was never struck off the roll of Irish solicitors, and testifying to his honourable character generally, 2506.

Increased knowledge of the question which induces witness to conclude that an average application of as much as 500 tons is not desirable, 2507-2510——Concurrence in Baron Liebig's view that sewage may be much improved in value by mixing other manures with it, 2511——Excess of witness's former estimate of the cost of horse-power for lifting the sewage to the required height, 2512-2515.

Calculation that even with so large a capital as 6,200,787 *l.* the ratepayers' moiety of the profits would amount to 900,000 *l.* a year, or about one-third of the local taxation of the metropolis, 2517-2520——The ratepayers would be fully protected under the Act from any liability, 2521——Whilst it would be unjust to the ratepayers to offer them a small rent, it would be impossible for witness to raise the capital if such a rent is demanded as is fair to the ratepayers, 2521-2529. 2551-2553——There would be no difficulty about the capital, coupled with a fixed rent of 10,000 *l.* a year, 2522, 2523——Reference to the views of the chairman of the Metropolitan Boaad as favourable to a fixed rent; he is not in accord with the ratepayers on this point, 2524-2528.

Twofold objection to any company utilising the sewage on land in their own possession,

Ellis, Thomas, and John Bowing. (Analysis of their Evidence)—*continued.*

2530——Witness's company would be merely carriers and retailers of the sewage, 2531——Calculation showing that there would be not the least difficulty in disposing of the whole of the sewage from day to day over the area proposed to be commanded by the mains, 2532——Further explanation that witness asks only for a conditional arrangement until the Act is obtained, and that previously to the passing of the Bill nothing is required from the public, 2533–2535——Heavy preliminary expenses which the promoters are prepared to pay, and proof therein of their *bona fides*, 2534. 2550–2555.

Examination with further reference to the refusal of the farmers to avail themselves of the sewage pumping works erected by the Duke of Northumberland; question more especially whether there may not have been an apprehension that poisonous matter, or chemical refuse, was introduced into the sewage, 2536–2548. 2586–2590——Very successful results obtained by Mr. Miles from applying the sewage of 30 persons over 14 acres at King's Weston, 2549.

Witness is prepared to prove his case when applying for his Bill, and to supply details which are now in doubt, 2550. 2558——Return to be derived from the works as soon as the mains are commenced to be laid from the summit reservoirs, 2556, 2557——Further complaint as to the animus displayed towards witness on the part of the Metropolitan Board; instances of this, 2556–2568.

Optional modes of application which may be adopted by the farmers, as by hose and jet, open drains, &c., 2569–2574——Very great value of the returns of Italian rye-grass obtained from sewaged land, 2575–2579——Much larger crops of grass obtained by Mr. Lawes from liquid sewage than from solid manure, 2579——Expediency of this country being independent of guano and other foreign manures, the supplies of which are very uncertain, 2583–2585——Opinion as to the sufficiency of a height of 300 feet from which to supply by gravitation, 2591–2593.

(*Mr. Bowing.*)—Prevention of any difficulty as regards friction if the sewage were lifted at different points, to a lower elevation at each lift, 2594–2596——Reference to a sample of the sewage as showing that there would be no difficulty about the pumping in consequence of any solid matter, 2597–2599.

Ellis, Mr. Correspondence and papers explanatory of the applications by Mr. Ellis for a concession of the sewage, and containing details of the arrangements proposed for its utilisation, *App.* 361 *et seq.*

Embankment (*Maplin Sands*). See *Metropolis Sewage and Essex Reclamation Company.*

Engineer's Department (*Metropolitan Board*). There are three assistant engineers under witness, who, as well as himself, are paid by salary exclusively, *Bazalgette* 5321–5325.

See also *Bazalgette, Mr.*

ENGINES (*LIFTING OR PUMPING LONDON SEWAGE*):

1. *Utilisation of Sewage.*
2. *Main Drainage Works.*

1. *Utilisation of Sewage:*

By the use of Cornish engines, enormous quantities of water may be lifted at very little cost, *Hopkins* 1075——Statement as to the amount of horse-power required in lifting or pumping the London sewage, *Sir C. Fox* and *M. Smith* 1310–1313. 1321, 1322. 1404–1406——Proposed utilisation of the pumping powers already provided by the Board at the outfalls, *Sir C. Fox* 1475–1477.

Objections to water or sewage being pumped to a height of more than 200 feet at one lift, on account of the strain upon the pump, *West* 2140–2144——For a lift of more than 200 feet it would be better to have two pumps, *ib.* 2142. 2144——Statement as to the horse-power required in proportion to the height to be lifted, *ib.* 2145–2147——Cost of about 35 *l.* per actual horse-power for the erection of the Cornish engine with boilers, exclusive of buildings; reduction to about 30 *l.* when erected in duplicate, *ib.* 2148–2152——Suggestions as to the kind of pumps and valves to be used in lifting the London sewage, *ib.* 2151–2153——Recommended use of a brass-wire sieve, in the form of a basket, for preventing any hard matter getting to the entrance of the suction pipe, *West* 2151. 2161, 2162. 2165–2167.

Estimate of from 50 *l.* to 55 *l.* per actual horse-power as the cost of erecting Cornish engines, including buildings and every other expense, *Hocking* 2191–2197——Practicability of a height of 300 feet being attained at one lift; it would be more advisable to have two engines for this height, *ib.* 2212–2214——Reference to a sample of the sewage as showing that there would be no difficulty about the pumping in consequence of any solid matter, *Bowing* 2597–2599.

Information relative to the amount of horse-power required to raise 10,000,000 gallons of water different heights in different periods, *Bateman* 2609–2616——About 1,300 net horse-power working constantly would be required to raise 10,000,000 gallons of water 100 feet in twenty-four hours, *ib.* 2609——The gross horse-power is

ENGINES (*LIFTING OR PUMPING LONDON SEWAGE*)—continued.

1. *Utilisation of Sewage*—continued.

is about one-third more than the net horse-power, or work produced, *Bateman* 2610–2612 ——Slight additional power required to raise sewage as compared with water, *ib.* 2617–2619——Allowance to be made for overcoming the friction in forcing sewage through pipes of different diameters, *ib.* 2628–2631——Nature of the increased expense in discharging sewage from a town in a hollow as compared with a town on a hill, *ib.* 2640, 2641.

Paper laid before the Committee by Mr. West, explanatory of the work performed by Cornish pumping engines and by rotary engines, *App.* 284–290.

2. *Main Drainage Works:*

Information as to the cost and character of the engines for the north and south side respectively, *Bazalgette* 5196–5207——Acceptance of the tender of Messrs. Watt & Co. for engines at Crossness, it having been the lowest, *ib.* 5201–5203——Authorities upon which it was decided to adopt these engines rather than Cornish engines, though the working expenses of the latter may probably be lighter, *ib.* 5206, 5207.

System of contract for the engines further adverted to with reference to the question of the lowest tender having been accepted, *Bazalgette* 5316–5320——Statement in further explanation of the non-adoption of Cornish engines, *ib.* 5329–5336.

Further explanation relative to the course pursued in regard to engines; less cost of the engines at Deptford than of the Cornish engines, *Bazalgette* 5825–5827——The price computed for the Cornish engines amounted to 60 *l.* per horse-power, whereas the engines at Deptford have been constructed for 44 *l.* per horse-power, *ib.*

Cause of the refusal of the tender of Mr. Hawthorne for the southern outfall engines, *Thwaites* 5857, 5858——Also of the refusal of Mr. Strap's tenders for engines at Deptford, *ib.* 5859, 5860.

Statement of the names of persons from whom tenders were received, of the amounts of each tender, and of the sureties proposed, *App.* 482, 483——Also of the successful tender, and its amount, *ib.* 487.

See also *Gravitation.*

Epidemics. Liability to epidemics through the use of water from rivers polluted by town sewage, *Rep.* vi.

Essex. Considerable area about Barking, &c., over which the sewage of London might be discharged by gravitation, *Bazalgette* 261–263. 301. 308–310——Difficulty in regard to an experimental application of the sewage to the low lands in Essex, *Thwaites* 302——Great difficulty in applying the London sewage to the low lands in Essex, as the water would hardly drain away, *Lawes* 4389, 4390. 4534–4536.

See also *Agriculture. Grass Land. Gravitation. Liquid Sewage Manure Company. London and Provincial Sewage Company. London and Provincial Towns Sewage Irrigation Company. London Sewage Utilisation Company. M'Clean, John R. Metropolis Sewage and Essex Reclamation Company. Pumping or Lifting the Sewage. Tenders* (*Utilisation of Sewage*). *Tiptree Hall Farm. Torrington, Lord, and others.*

Essex, Earl of. Statement as to Lord Essex not having experienced annoyance from the sewage used on his demesne; he does not deodorise it, *Ellis* 2020. 2022——Inference as to a large application of sewage to grass land not having proved successful in the case of Lord Essex, *ib.* 2475–2478. 2580——Partial character of the application of sewage at Watford; satisfaction expressed by Lord Essex with the results, *Rawlinson* 4094——Reference to the practice of Lord Essex to apply the sewage to different portions of his land daily; belief that this is a better plan than to distribute the sewage daily over the whole of the land, *Lawes* 4647–4656. 4660–4662.

Quotation by Mr. Shepherd of statements by Lord Essex in 1860, as to the manurial value of the Watford sewage, as applied to grass land, &c. at Cassiobury Park, *App.* 345–347.

Communication from Lord Essex to Mr. Ellis in May 1861, explanatory of the results derived by him from the application of sewage to grass land, *App.* 376.

Essex Reclamation Company. See *Metropolis Sewage and Essex Reclamation Company.*

Eureka Company. Proposition by this Company for applying a system of tanks for the reception of excrementitious matter from houses, with a view to converting it into a solid manure, *Taylor,* 3945——Arrangements of the Eureka Company for utilising the solid refuse in cesspools at Ashton-under-Lyne, first removing it separately from each house, *Rawlinson* 4174, 4175.

Excreta. See *Cesspools. Eureka Company. Manchester. Sewers. Solid Manure. Value of Sewage. Water Closets.*

Exeter. Prospect of the adoption of some plans made by witness several years ago for utilising the sewage of Exeter, *Whitehead* 2699–2702——Very polluted condition of the River Exe, on account of the sewage of Exeter, *ib.* 2739–2743——Great facility with which the Exeter sewage might be applied to land, *ib.* 2744–2748. 2828–2830. 2839. 2849.

Exmouth. Plans made by witness in 1854 for utilising the sewage of Exmouth; cause of their not having been carried out, *Whitehead* 2703, 2704——Nuisance arising from the sewage; facility for utilising it, *ib.* 2474–2781.

Experiments. Character of the experiments required before a decision can safely be arrived at by the Metropolitan Board as to the best plan for utilising the sewage, *Thwaites* 251. 295–297. 302–307. 377——Obstacle to a satisfactory experimental application of the sewage to the low lands below the outfall, *ib.* 302——Insufficiency of the experiments at Rugby, Edinburgh, Croydon, &c. as a data upon which to calculate as to the value and proper mode of application of the London sewage, *ib.* 303–307. 349–353——Until it is definitely shown by experiments what the value of the sewage is, the public will not believe there is much value in it, *Roberts* 1190——Evidence relative to the failure of the Leicester experiments, that is, for extracting a solid manure from sewage, *Smith* 1559; *Taylor* 3914–3916; *Rawlinson* 4031–4034; *Way* 4901–4903.

See also *Alnwick.* *Carlisle.* *Croydon.* *Edinburgh.* *Essex, Earl of.* *Grass Land.* *Kirkman, C. F.* *Miles, Mr.* *Rugby.* *Sandy Soils.* *Tiptree Hall Farm.*

Extra Works (Main Drainage Contracts). System in contracts generally of paying by a schedule of prices for extra works not included in the specifications, *Ridley* 5503–5507 —— Definite sums are sometimes put down for extra works, the amount being deducted if the works are not executed, *M'Cormick* 5508–5511. 5565, 5566.

Explanation of the system in regard to the addition to each contract of a certain sum for extra works and for provisional quantities, payment being contingent upon the additional work performed, *Thwaites* 5876–5879——Details as to the amounts allowed for extra works under particular contracts, and as to the payments made in addition thereto, *ib.* 5880–5900.

Statement of the sums of money included in the respective contracts as a provision for extra works, and of the amount paid for extra works. *App.* 495, 496.

Explanation by Mr. Bazalgette as to its being the usual practice in making estimates to add ten per cent. to cover contingencies, *App.* 498.

F.

Farm Yard Manure. Proposed use of the sewage in addition to other manures; farm yard manure, &c. being still used as well as sewage, *Ellis* 1789, 1790.

Farmers. See *Agriculture.* *Alnwick.*

Farringdon Ward. Resolutions adopted by the Ward of Farringdon Without with reference to the value of sewage as a manure, and the advantages of utilising it as under the scheme of Mr. Ellis. *App.* 454.

Fat Stock. Intended supply of the London market with fat stock from the sewaged land, held by the company promoted by Lord Torrington and others, *Smith* 1534.

Ffennell, William J. (Analysis of his Evidence.)—Is inspector of fisheries for England, and a commissioner of fisheries for Scotland, 2918——Testifies to the very injurious effect of town sewage in rivers upon the quantity of fish, 2919–2925. 2987——Considerable injury still caused to the rivers and the fish by gas refuse; respects in which the law on this score requires alteration, 2925. 2944–2948. 2954–2962. 3004–3006——Uselessness of attempting to breed salmon in the Thames so long as the sewage of London flows into it; very valuable salmon fisheries in the river if purified, 2926–2934.

Information relative to the extensive pollution of rivers and destruction of fish by the refuse from mines; suggestions as to the means for correcting this, 2934–2943. 2949–2953. 2971–2975. 2982–3001——Functions proposed to be vested in the inspectors of mines with a view to the protection of the rivers, 2935. 2943. 2985. 2998——Frequent instances of manufacturers allowing deleterious refuse to escape into the rivers; restrictions required, 2963–2971. 2976–2981.

Importance of the work of protecting the rivers being the duty of public functionaries, and being undertaken at the public expense, 2973. 2986–3007——Expediency of one authority and of unity of action over the whole of each catchment basin, 2992–2996——The salmon fisheries are to a great extent the property of the public, and should be protected at the public expense, 2997–3007.

Filtration. Effect of a preliminary filtration of the London sewage in preventing any pollution of the streams, after the application to the land, *Mechi* 3326. 3332. 3383——Information relative to the sewage filtration works at Croydon, and their effect upon the sewage, *ib.* 3364–3369.

Probable continuance of the pollution and injurious state of the Thames water even after filtration, *Acland* 3474–3478——Complete failure of the filter bed at Rugby, *Walker* 3728, 3729——Ineffectiveness of filtration works as a means of preventing pollution of the rivers, *Taylor* 3969–3971.

See also *Osier Beds.*

Finch,

Finch, G. Witness was employed in 1862 by Mr. Finch, the owner of the greater part of Foulness Island, to examine the scheme of the Metropolis Sewage and Essex Reclamation Company; made a careful examination of the scheme, *Hopkins* 929–940——It was proposed to carry the sewage across Mr. Finch's land in Foulness Island in an open culvert, from which it was apprehended great nuisance would arise, *ib.* 933–935.

Statement by Mr. Finch, submitted to the Metropolitan Board in January 1862, in opposition to the proposed scheme, *App.* 430.

Report by Mr. Hopkins, dated 5 February 1862, at the instance of Mr. Finch, setting forth in detail his grounds for objecting to the proposed plan, *App.* 431–433.

Fish. Destruction of the fish in streams or rivers receiving sewage deodorised with lime, *Whitehead* 2718. 2722. 2727; *Taylor* 3827, 3828—— Decided opinion as to sewaged rivers being destructive to fish, *Whitehead* 2849–2854.

Witness testifies to the very injurious effect of town sewage in rivers upon the quantity of fish, *Ffennell* 2919–2925. 2987——Extensive destruction of fish in rivers by the pollution from mines; suggestions for correcting this evil, *ib.* 2934–2943. 2949–2953. 2971–2975. 2982–3001.

Fish are not destroyed when the escape of manure from the land is but moderate, *Mechi* 3353——Effect of fish in helping to purify the river, whereas noxious sewage destroys the fish, *Ackland* 3482–3484——Absence of any injury to the fish from the Carlisle sewage, it being discharged into the river before putrefaction has set in, *Rawlinson* 4098, 4099.

Reference by the Committee to the effect of sewage matter in rivers as regards the destruction of fish; expediency on this score of remedial and purifying measures being adopted. *Rep.* vi.

See also *Salmon Fisheries.*

Foreign Manures. Expediency of this country being independent of guano and other foreign manures, the supplies of which are very uncertain, *Ellis* 2583–2585.

Foulness Island (Essex). See *Metropolis Sewage and Essex Reclamation Company.*

Fox, Sir Charles, and Richard Smith. (Analysis of their Evidence.)—(*Sir C. Fox.*) In conjunction with Lord Torrington sent in a tender to the Board of Works, dated 6 July 1863, for utilising the whole of the sewage in a liquid state, 1260–1262——Objected to comply with the conditions of the Board's advertisement, as rendering it exceedingly difficult to obtain the land upon which to apply the sewage, 1263–1266——Concurs with Professor Liebig that the value of the sewage is about 1⅓*d.* per ton, 1267——Has not calculated what rental the land would fetch when improved by the sewage, 1268–1270.

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1. *Chief Advantage of Sewage as applied to Grass Land.*
2. *Quantity desirable to be applied per Acre.*

1. *Chief Advantage of Sewage as applied to Grass Land:*

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1. *Chief Advantage of Sewage as applied to Grass Land*—continued.

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Hughes, Samuel, C. E. Letter from Mr. Hughes to the Chairman of the Metropolitan Board, dated 3d August 1861, supporting the application of Mr. Ellis for a conditional concession of the sewage on certain terms, *App.* 380, 381——Estimate by Mr. Hughes of the cost of raising and distributing the sewage, *ib.* 417, 418.

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Johnson, Charles. Reference to a proposal from Mr. Charles Johnson, in 1863, for converting the sewage into a solid, or powder; opinion adverse to this plan, *Thwaites* 219–227——Letter from Mr. Johnson to the Metropolitan Board, dated Dickleburgh, Norfolk, 20th October 1863, offering to deal with the sewage by converting it into a solid manure, *App.* 457.

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Smaller results produced by sewage applications in 1862 than in 1863, on account of the colder temperature in the former year, 4657-4659. 4668-4671——Opinion that, with an unlimited supply of sewage, more pasture grass than Italian rye-grass may be produced, 4664-4667——Impracticability of forming any accurate estimate of the London sewage until it arrives *en masse* at Barking, 4673-4677.

Whether on soil like that at Rugby, or on sandy soil, witness would use 50,000 or 70,000 tons per acre if it were delivered for nothing, 4678-4680——The more witness had to pay for the sewage the less he would use, 4681——At one-farthing a ton he would begin by using 5,000 or 6,000 tons an acre, but not more than 4,000 tons, if so much, if had to pay one-halfpenny a ton; much would depend upon whether he had to find pipes and hose, 4682-4688——At 1 ½ *d.* or 2 *d.* a ton witness would rather be without the sewage, unless he could use it when he liked, 4689-4691——Very clumsy application of the sewage at Edinburgh, there being a large waste of fertilizing matter, 4692-4697.

Lawes, Mr. Explanation as to the authority upon which witness condemns the conclusions of Mr. Lawes as altogether unreliable, *Ellis* 2422–2426——Comment upon the fact of Mr. Lawes being entrusted with the experiments about town sewage, he being so deeply interested in artificial manures, *ib.* 2463.

The publication by Mr. Lawes of his private experiments has tended to prejudice his interests in the sale of artificial manure, *Way* 4792–4794.

Leamington. Nature of the restriction in the Local Government Act of the town of Leamington in regard to the discharge of sewage, *Gael* 3158, 3159.

Legal Proceedings (*Pollution of Rivers*). Great expense and uncertainty of legal proceedings for excluding sewage, &c. from streams and rivers, so that further preventive facilities are required, *Gael* 3236 *et seq.*——Impracticability by mere recourse to law of preventing the discharge of sewage into the Thames, *ib.* 3286–3288. 3294–3296.

Increased number of legal proceedings and of injunctions with reference to the pollution of the streams, *Taylor* 3814, 3815. 3882——Statement in connection with the absence of any authority on the part of the public for enforcing the law relative to the pollution of streams; inexpediency of this duty being devolved upon witness or the Local Government Office in London, *ib.* 3853–3856. 3926–3934——Circumstances under which considerable difficulty and expense are involved in obtaining injunctions against persons for polluting streams, *ib.* 3888–3892——Difficulty in regard to private individuals summoning persons who pollute the streams before the magistrates in petty sessions, *ib.* 3896.

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Legislation (*Sewage Discharge*). Approval of a legislative provision that sewage should not, any more than gas refuse, be allowed to flow into rivers, *Whitehead* 2818–2820——Local Boards should be compelled by law to adopt preventive measures, *ib.* 2843. 2896——Want of some preventive legislation with reference to Local Boards and manufacturers allowing the streams and rivers to be polluted, *Gael* 3236 *et seq.*——Extended powers desirable to be given to large towns in the formation of outfall works, *ib.* 3297–3305——Respects in which the extension to country towns of similar powers to those under the Main Drainage Act or the Local Health Act, would be inadequate as regards the effectual disposal of the sewage, *ib.* 3298–3303.

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Leicester. Great failure commercially of the precipitation experiments at Leicester, *Smith* 1559; *Taylor* 3914-3619; *Rawlinson* 40314034; *Way* 4901–4903.

Liebig, Baron. Opinion of Baron Liebig that the value of the sewage would be greatly increased by the use of phosphates, *Ellis* 1809. 1988——Concurrence in Baron Liebig's opinion that sewage may be much improved in value by mixing other manures with it, *ib.* 2511.

Views expressed by Baron Liebig in his "Agricultural Chemistry" as to the important manurial properties contained in human excreta, *App.* 344.

Extract from letter from Baron Liebig to the "Times," in December 1859, upon the subject of the impoverishment of the land, and the expediency of economising manures, *App.* 348, 349.

Letters from Baron von Liebig to Mr. Shepherd in January 1860, in approval generally of the scheme of the latter for utilising the sewage of London, and testifying to the practicability of the scheme, *App.* 349.

Letter from Baron Liebig to Mr. Ellis, dated 22 June 1863, showing his views as to the national importance of utilising the sewage of the metropolis, and of towns generally, *App.* 422.

Lifting or Pumping the Sewage, &c. See *Pumping, &c.*

Lime Process. Several respects in which the lime process of purification of sewage is injurious and objectionable, *Whitehead* 2718. 2721–2726——Destruction of fish where the lime process is used, *Whitehead,* 2718. 2722. 2727; *Taylor* 3827, 3828.

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Statement as to the valuable effect of precipitation by lime in purifying the water, *Way* 4705. 4742–4748. 4875–4883——Effect of precipitation, if applied at Oxford, &c., in greatly improving the London water supply, *ib.* 4705. 4742–4748——Lime may be used as a purifier without the fish being destroyed, *ib.* 4878–4882.

Liquid Sewage or Manure. Particulars as to the terms and outlines of the plans, submitted by the several companies or individuals, for dealing with the sewage in a liquid state, *Thwaites* 32 *et seq.*——More profitable application of sewage in a liquid state than by solidifying it, *ib.* 58–60. 222, 223——Conclusion as to the sewage being remunerative only when applied in a liquid state, *Sir C. Fox and Mr. Smith* 1286, 1287. 1553. 1568——The fertilising matter is all in the liquid, *Shepherd* 1617.

Witness contends that the effect of sewage in a liquid state is unquestionably greater than when the manure is extracted and dried, *Ellis* 1797–1801, 1804. 2415, 2416——Statement as to witness's practice of liquifying manure before application, and as to the mode of application, *Mechi* 3337. 3412–3416. 3421. 3424. 3436–3441.

Advantage if the sewage of houses could be applied in a less diluted form, *Walker* 3620. 3673. 3674——Witness does not use any liquid manure on his own farm, *Lawes* 4494. 4495——Very valuable effect of weak sewage as used in the irrigation of land near Milan, *Lawes* 4635–4639; *Way* 4721, 4722. 4884–4887. 4906–4909——Necessity of using the sewage of towns in a liquid form upon land, as the only alternative if it be excluded from the rivers, *Way* 4709–4712. 4754.

The Committee conclude that the sewage may be utilised in a liquid form to the pecuniary advantage of the rate-payers, *Rep.* v.

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LIQUID SEWAGE MANURE COMPANY:

Reference to the proposal by Mr. J. J. Moore to utilise the sewage of the metropolis in a liquid form; terms of this tender, *Thwaites* 47–50——Witness has submitted three or four proposals to the Metropolitan Board of Works for dealing with the sewage, *Moore* 1095–1100——Witness did not limit his plan to an area of 20,000 acres, but would apply it to a more extended area, according to the mode of cultivation, *ib.* 1096. 1110–1116——Terms offered to the Board by witness's plan of 1860; capital then contemplated, *ib.* 1103, 1104.

Engagement between witness and the occupiers of 20,000 acres of land in Essex, whereby the latter undertook to take the sewage on certain terms; this referred to his plan of 1862, *Moore* 1105, 1106. 1110, 1111. 1155–1172——Proposition in 1862, that if the Board would pump the sewage to a height of 200 feet, witness would ensure them a farthing a ton, which would leave them a profit of 136,000*l.* a year, *ib.* 1107–1132. 1145——The price to the occupiers of the 20,000 acres was fixed at a 1*d.* a ton; conditions which accompanied these terms, *ib.* 1138. 1155–1172.

System of pipes, and of continuous pressure, by which it is proposed to convey the sewage from the reservoir to each farm, *Moore* 1140–1154——Explanation as to the mode in which witness proposes to distribute the sewage after it reaches each farm or holding; character of the ground adverted to herein, *ib.* 1161–1182.

Scheme suggested by Mr. Moore for an altered system of metropolitan drainage, and for utilising the sewage through the medium of a company, termed the Liquid Sewage Manure Company, *App.* 315 *et seq.*——Prospectus of the company; arguments adduced therein in support of the scheme promoted by Mr. Moore, *ib.* 325, 326——Offer by Mr. Moore on the part of the company, in July 1863, to take all the sewage at the rate of one farthing per ton for every ton raised by the Board to the height of 200 feet, *ib.* 329, 330.

Local Boards. Necessity of an Act of Parliament compelling Local Boards to take action in the matter of sewage discharge into the streams and rivers, *Whitehead* 2843. 2896——Very expensive and uncertain character of legal proceedings against Local Boards, or against manufacturers, for allowing sewage or refuse to be discharged into rivers, so that improved preventive measures are much required, *Gael* 3236 *et seq.*——Considerable difficulty at times in compelling Local Boards of Health, or Improvement Commissioners, to take proceedings for the suppression of nuisances; question as to the amount of Government interference desirable in such cases, *ib.* 3277–3285. 3306–3312.

Statement of the powers acquired by Local Boards adopting the Local Government Act, in regard to sewage, *Taylor* 3798–3810——Conditions subject to which Local Boards may make sewers and reservoirs, beyond their district, for the distribution of sewage, *ib.* 3807–3812——Practice generally of Local Boards in dealing with the sewage, to run it into the nearest river or stream, *ib.* 3813.

Local Boards—continued.

Increased number of injunctions against Local Boards, in consequence of the pollution of the stream, *Taylor* 3814, 3815. 3882——Extent of the power of Local Boards in regard to acquiring land beyond their districts, in connection with sewage works, *ib.* 3878–3880. 3903, 3904. 3939, 3940——The Local Boards are in one sense the great offenders; that is as regards the discharge of excrementitious matter into the sewers and the streams, *ib.* 3897——Probable usefulness of a power in Local Boards to take proceedings against other Local Boards responsible for the pollution of the same river higher up the stream, *ib.* 3905-3907——Question as to the expediency of Local Boards being brought under more direct control by the Central Board, *ib.* 3946–3950.

Consideration of the question of an increased power in Local Boards for taking land compulsorily, in order to utilising the sewage; difficulty only as regards rating powers, *Rawlinson.* 4081–4088. 4104. 4166–4168.

Suggested legislative provision to be included in a general enactment, compelling Local Boards to render the sewage of their districts innocuous by application to the land for agricultural purposes, *Rep.* vii.

See also *Croydon,* 1. *Hitchin. Keighley. Legislation. Oxford. Uxbridge. Watershed Boards.*

Local Government Act. Restriction under the Local Government Act of 1861, with reference to the discharge of sewage, *Gael* 3157, 3158. 3254——Considerations as to the expediency of extending the Local Government Act to the catchment-basins or watersheds of rivers, *Gael* 3192–3228; *Acland* 3462. 3476. 3479-3481; *Taylor* 3863-3877. 3950–3964——Means under the Local Government Act for preventing the discharge of human excrement from privies directly communicating with the river, *Acland* 3504–3508.

Nature of the extended powers given to Local Boards to deal with sewage by the Local Government Act in enlargement of the powers already possessed under the Public Health Act, *Taylor* 3803–3810——Application of the Local Government Act to single towns and districts, there being no power applicable to whole catchment basins, *ib.* 3836–3840——Disapproval of the application of the Act to whole watersheds or catchment basins, *ib.* 3863——Advantage of a Local Government Act of general application, in lieu of an Act which may be adopted or applied, *ib.* 3885–3887.

Reference by the Committee to the views of Dr. Acland and other witnesses in favour of extending the Local Government Act to entire watersheds, *Rep.* vi, vii.

Local Government Office. Very limited powers of the Local Government Office in London over Local Boards of towns in respect of nuisances, *Gael* 3283. 3306-3312——Absence of any real power in the Local Government Office over the acts of the Local Boards: opinions as to the inexpediency of such power, *Taylor* 3946–3950.

London, Midland Counties, and General Sewage Irrigation Company. Statement as to witness having designated himself engineer to the "London, Midland Counties, and General Sewage Irrigation Company," which is just formed, *Shepherd* 1708–1715.

LONDON AND PROVINCIAL SEWAGE COMPANY:

Witness, who is engineer of the London and Provincial Sewage Company, has tendered for the London sewage, in order to utilise it in a liquid state, *Shepherd* 1606–1610——Calculates upon the delivery of the sewage upon lands to a distance of 100 miles at a cost of one halfpenny per ton, *ib.* 1611–1616. 1691–1697——Proposes that all surplus profits of above seven and a-half per cent. be shared in by the Metropolitan Board, *ib.* 1615. 1700——Particulars as to the reservoirs, mains, and other works for the distribution of the sewage upon witness's plan, *ib.* 1621–1651——It was proposed by witness in 1857 to pump the sewage to two reservoirs, at Shooter's-hill and Hampstead-hill respectively, *ib.* 1621.

Consideration of the cost of the works in detail; enormous aggregate if a radius of 100 miles round London be dealt with in its entirety, which however witness never contemplated, *Shepherd* 1641 *et seq.*

Correspondence between Mr. Shepherd and the Board; sundry explanations given by Mr. Shepherd in support of his scheme, and of his calculations as to the profitable returns to be derived therefrom, *App.* 339 *et seq.*

LONDON AND PROVINCIAL TOWNS SEWAGE IRRIGATION COMPANY:

1. *Comments by Mr. Shepherd upon the Authorship of the Scheme.*
2. *Personal Explanations by the Promoter: Experience upon which he grounds his Scheme.*
3. *Comments by the Promoter upon the action of the Metropolitan Board of Works in the matter.*
4. *Proposal to apply the Sewage in Small Quantities over an Extended Area.*
5. *System of Reservoirs and of Mains, with particulars as to the Works generally.*

6. *Intended*

LONDON AND PROVINCIAL TOWNS SEWAGE IRRIGATION COMPANY—continued.

6. *Intended Supply by Meter to the Farmers: the latter being responsible for the Subsidiary Pipes.*
7. *Non-apprehension of any Difficulty in disposing of the whole of the London Sewage.*
8. *Capital to be provided by the Company.*
9. *Working Expenses.*
10. *Capital to be expended in Sub-mains by the Farmers, &c.*
11. *Terms offered to the Ratepayers, in connection with the provision of the required Capital.*
12. *Security for the* bonâ fides *of the Undertaking.*
13. *Conditional Arrangement now asked for by the Promoter.*
14. *Time required for carrying out the Works.*
15. *Large Profits anticipated for the Ratepayers.*
16. *Views expressed by Ratepayers in favour of the Scheme.*
17. *Nuisance apprehended by the Board of Works.*
18. *Correspondence, Estimates, &c., in detailed elucidation of the Scheme, as submitted to the Metropolitan Board.*

1. *Comments by Mr. Shepherd upon the Authorship of the Scheme:*

The plan of Mr. Ellis is taken entirely from that of witness, *Shepherd* 1630.

Statement by Mr. Shepherd, in letter to the Metropolitan Board in December 1861, that Mr. Ellis was struck off the rolls in Ireland, *App.* 351.

2. *Personal Explanations by the Promoter; experience upon which he grounds his Scheme:*

Witness is by profession a solicitor, but has not practised for many years; was never struck off the rolls, *Ellis* 1726——Witness is conversant with agriculture, but bases his scheme not upon any experience of his own relative to town sewage, but upon results well authenticated by others, and more especially upon the analyses and calculations made by Messrs. Hofmann and Witt, *ib.* 1732–1743.

Witness further states that he has never made any experiments with town sewage as applied to agriculture; his experience as an agriculturist further adverted to, *Ellis* 2002–2005. 2132–2137——Extent to which witness has had the advice of engineers as to the practicability of his plan, the cost of pumping, system of distributing pipes, &c., *ib.* 2109–2120——Consultation of Mr. Hughes by witness, *ib.* 2120.

Nature of the experience of witness further adverted to; he was specially educated with regard to agriculture, *Ellis* 2498–2506——Letter from a master in Chancery in Ireland, showing that witness was never struck off the rolls of Irish solicitors, and tesfying to his honourable character generally, *ib.* 2506.

3. *Comments by the Promoter upon the action of the Metropolitan Board of Works on the matter:*

Statement as to the Board of Works having on the 16th November 1861 applied to witness for details of his plans, which it would have cost him 130,000*l.* to supply; copy of this application, *Ellis* 1935–1937. 1947–1951. 2084–2086——Complaint as to the foregoing application having been made to witness some days after the Main Drainage Committee of the Board had directed Mr. Bazalgette to report upon the scheme of Messrs. Napier and Hope, *ib.* 1938. 1945–1958.

Protest made by witness against publicity being given to his examination before the Board of Works in February last; complaint more especially that his evidence was falsified, and an incorrect report printed, *Ellis* 1961–1987——Further complaint as to the animus displayed towards witness on the part of the Metropolitan Board: instances of this, *ib.* 2559–2568.

4. *Proposal to apply the Sewage in Small Quantities over an Extended Area:*

Reference to the proposition by Mr. Ellis for utilising the sewage in a liquid state, and applying it over a large space (522,104 acres); rent on terms offered, *Thwaites* 62–69.

Witness proposes to distribute the sewage of London over an area of about 500,000 acres, *Ellis* 1727——Evidence in support of the proposition to supply the sewage in limited dressings over an extended area, or at the rate of about 500 tons per acre, *ib.* 1790–1793. 1812 *et seq*——Explanation as to the proposed works extending over 1,075,200 acres, so as to command an area of about half that extent for actual distribution, *ib.* 1824–1828——Information as to the proposed area of distribution on the south side and North side respectively, *Bowing* 1892–1896——Opinion, founded on further consideration, that on an average a smaller quantity than 500 tons per annum is as much as can be disposed of to farmers at the rate of two-pence per ton, *Ellis* 2046. 2432–2442. 2532. 2507–2511——Five hundred tons per acre is probably too large a quantity to expect the farmers to take at all times, *ib.* 2046.

LONDON AND PROVINCIAL TOWNS SEWAGE IRRIGATION COMPANY—continued.

5. *System of Reservoirs and of Mains, with Particulars as to the Works generally:*

Particulars in connection with the supply of sewage received into the outfall tanks of the Metropolitan Board, and the arrangements under witness's scheme for pumping from the outfall to reservoirs at Hampstead Hill and Shooter's Hill, *Ellis* 1831–1861——Proposed use of fine screens for preventing sediment or deposits getting into the mains, *ib.* 1854, 1855. 2017, 2018.——It is proposed to cover or arch over the reservoirs, which are about nineteen acres in extent, so as to prevent the possibility of any nuisance, *ib.* 1881. 1883. 2487–2489.

Information relative to the length, size, and cost of the proposed mains for conveying the sewage from the outfall to the high level reservoirs, *Bowing* 1862–1872——Twofold size of the reservoirs as compared with the outfall tanks; objects thereof, *ib.* 1873–1878——Probable shape, mode of construction, and area of the reservoirs; question as to the sufficiency of the estimated cost adverted to hereon, *ib.* 1879–1890——Rate of fall of the sewage from the reservoirs through the distributing mains, *ib.* 1897——The mains are laid below ground, *ib.* 1898——There is, on an average, one mile of main to each square mile of country, *ib.* 1900——Division of the area into concentric circles, there being different sizes of mains for the different areas, *ib.* 1901. 1908.

Limited amount of deposit which witness expects to have to deal with after receiving the sewage from the Board of Works, *Ellis* 2006–2011——Depth below the surface at which it is proposed to take the mains, *ib.* 2012, 2023——Further explanations relative to the arrangements for conveying the sewage to the high level reservoirs, *ib.* 2054–2059——The reservoirs will not be placed in any spot of which the Board of Works disapprove, other sites besides Hampstead Hill and Shooter's Hill being available, *ib.* 2060, 2061. 2100–2104——Means of removing any residuum in the reservoirs, *ib.* 2062, 2063.

Intended laying of the pipes or mains along the roads, *Ellis* 2083——Sufficient size of the proposed reservoirs for dealing with the sewage as computed by Mr. Bazalgette, *ib.* 2093–2098——Safety of the proposed mode of construction, that is, by excavating on an eminence, *ib.* 2103. 2483–2485. 2581, 2582.

Further explanations on the subject of the proposed summit reservoirs, their site, mode of construction, &c., *Ellis* 2479–2489. 2516. 2581, 2582.

6. *Intended Supply by Meter to the Farmers; the latter being responsible for the Subsidiary Pipes:*

The company do not propose directly to utilise the sewage, but to retail it entirely to farmers, *Ellis* 1728——It is proposed to follow the practice of the water companies, and to allow the farmers to lay down the pipes and distribute as they please, the sewage being supplied from the main by meter, *ib.* 1913–1917. 2013. 2019——Proposed charge for the sewage whenever distributed, *ib.* 2014.

Witness further explains that the company propose to lay down merely the mains along the roads; the field pipes to be laid down at the expense of the farmers or landlords, *Ellis* 2443. 2569——The company would be merely carriers and retailers of the sewage, *ib.* 2531——Optional modes of application which may be adopted by the farmers, as by hose and jet, open drains, &c., *ib.* 2569–2574.

7. *Non-apprehension of any Difficulty in disposing of the whole of the London Sewage:*

Way in which the sewage may be got rid of if the farmers will not pay for it; witness has no apprehensions on the latter score, *Ellis* 2064–2066. 2087–2092——Calculation showing that there would be not the least difficulty in disposing of the whole of the sewage from day to day over the area proposed to be commanded by the mains, *ib.* 2532.

8. *Capital to be provided by the Company:*

Without an accurate survey of the area taken, it is difficult to state the capital necessary, but witness estimates that 4,000,000 *l.* will be ample for the works, *Ellis* 1729, 1730——The cost of the works will probably not be more than 3,500,000 *l.*, *ib.* 1829. 1996.

Total of 132,080 *l.* as the estimate for the reservoirs, *Bowing* 1884——Total of 4,053,331 *l.* as the cost of all the distributing mains, including the laying, *ib.* 1909–1912——Aggregate outlay of 5,868,662 *l.*, if the works be carried out on a certain scale; opinion that this is greatly in excess of what is required, *ib.* 1923. 1926.

Confidence of witness in regard to the company procuring the required capital, *Ellis*, 1993–1996——Excess of witness's former estimate of the cost of horse-power for lifting the sewage to the requisite height, *ib.* 2512–2515.

9. *Working Expenses:*

Estimate of 332,125 *l.* as the total annual working expenses, *Bowing* 1918–1920.

10. *Capital*

LONDON AND PROVINCIAL TOWNS SEWAGE IRRIGATION COMPANY—continued.

10. *Capital to be expended in Sub-mains by the Farmers, &c.:*

Information as to the probable cost per acre of the sub-mains or distributing apparatus to be supplied by the farmers; probable aggregate expenditure of 2,000,000 *l.* for this purpose, *Ellis* 2444-2457.

11. *Terms offered to the Ratepayers in connection with the provision of the required Capital:*

Inability of witness to raise the required capital if a fixed annual rent were demanded by the Board, or a royalty per ton were required, *Ellis* 1935. 1940——Injustice to the ratepayers if the scheme offered them only a limited though certain rent, *ib.* 2106-2108. 2123-2125.

Whilst it would be unjust to the ratepayers to offer them a small rent it would be impossible for witness to raise the capital if such a rent is demanded as is fair to the ratepayers, *Ellis* 2521-2529. 2551-2553——There would be no difficulty about the capital, coupled with a fixed rent of 10,000 *l.* a year, *ib.* 2522, 2523.

12. *Security for the* bonâ fides *of the Undertaking:*

Witness and the other promoters of the scheme are prepared to lodge a sum of 60,000 *l.* for preliminary expenses, and are desirous of being prevented from raising any of the capital until they have obtained an Act, *Ellis* 1943, 1944. 2034-2037. 2072-2079. 2120, 2121.

Further reference to the heavy preliminary expenses which the promoters are prepared to pay, and proof thereby of their *bonâ fides, Ellis* 2534. 2550-2552——Witness is prepared to prove his case when applying for his Bill, and to supply details which are now in doubt, *ib.* 2550. 2558.

13. *Conditional arrangement now asked for by the Promoter:*

Witness at present asks only for a conditional arrangement, to be turned into a conditional concession of the sewage when an Act has been obtained, a company formed, and the necessary capital raised; two years would suffice for this being done, *Ellis* 1996-1999. 2120. 2126-2128.

Further explanation that witness asks only for a conditional arrangement until the Act is obtained, and that previously to the passing of the Bill nothing is required from the public, *Ellis* 2533-2535.

14. *Time required for carrying out the Works:*

Necessity of about three years for carrying out the works after the Act has been obtained, *Ellis* 2024-2029.

15. *Large Profits anticipated for the Ratepayers:*

Prospect of the ratepayers receiving a profit of more than 700,000 *l.* a year, *Ellis* 1830——Net estimated annual profit of 1,884,979 *l.*, one half of which would go to the ratepayers, *Bowing* 1926, 1927——Anticipated demand for the sewage by the farmers; otherwise the project would be a failure, *Ellis* 1932. 1995. 2000, 2001.

Witness has not altered his plan since his first tender, except that he now offers more favourable terms to the ratepayers, *Ellis* 1933, 1934——Inaccuracy of a statement that witness had demanded a preferential dividend of twenty per cent. for the company, *ib.* 1941, 1942——Calculation as to the amount of profit to be obtained if the farmers will pay one penny per ton for the sewage, *ib.* 2039-2046——Belief that in a few years witness will make two pence a ton, less the working expenses, *ib.* 2108.

Statement in further support of the conclusion that farmers would pay a fair price for the sewage, or two pence per ton, if supplied to them in limited quantities, *Ellis* 2432-2442. 2490-2495. 2510, 2511. 2532——Calculation that even with so large a capital as 6,200,787 *l.* the ratepayers' moiety of the profits would amount to 900,000 *l.* a year, or about one-third of the local taxation of the metropolis, *ib.* 2517-2520——Return to be derived from the works as soon as the mains are commenced to be laid from the summit reservoirs, *ib.* 2559, 2557.

16. *Views expressed by Ratepayers in favour of the Scheme:*

Reference to the resolutions passed by the ratepayers in favour of the scheme; probability of these resolutions being the result of the large profits held out under witness's anticipations, *Ellis* 1941. 2104, 2105. 2525.

Resolution of the parish of St. John, Hackney, in support of the tender submitted by Mr. Ellis, *App.* 449.

Resolutions of the Bishopsgate Ward Ratepayers' Association in favour of the scheme of Mr. Ellis, *App.* 449, 450. 452.

London and Provincial Towns Sewage Irrigation Company— continued.

16. *Views expressed by Ratepayers in favour of the Scheme*—continued.

Resolutions adopted at a meeting of the inhabitants of Portsoken Ward to the effect that the proposition of Mr. Ellis is entitled to the support of the metropolitan ratepayers, *App.* 453.

Resolutions of the Ward of Farringdon Without as to the greater advantages held out to the ratepayers by this scheme than by any other scheme that has yet been submitted, *App.* 454.

17. *Nuisance apprehended by the Board of Works:*

Grounds for apprehending a nuisance in carrying out Mr. Ellis's plan, that is, in connection with the pumping of the sewage to the high level reservoirs and the mode of distribution thence over so very extended an area, *Thwaites* 93-95. 273, 274.

18. *Correspondence, Estimates, &c., in detailed elucidation of the Scheme, as submitted to the Metropolitan Board:*

Papers explanatory in detail of the schemes of the company, including numerous communications from Mr. Ellis to the Metropolitan Board in elucidation and support of the scheme, *App.* 361 *et seq.*——Detailed estimate of plan on maximum area, to absorb profitably the whole sewage; also appendix in explanation, *ib.* 364-376——Calculations submitted by Mr. Ellis for determining the probable area required for the sewage, *ib.* 396-400——Details supplied by Mr. Ellis with reference to the capital required for carrying out his scheme, and the revenue to be derived, *ib.* 400-406.

London Sewage Utilisation Company:

Proposal by the London Sewage Utilisation Company to utilise the sewage in a liquid state, *Thwaites* 32—— Belief that the area proposed to be dealt with by this company was about 20,000 acres, *Bazalgette* 37-44——Terms or rent offered by the company, *ib.* 45.

The London Sewage Utilisation Company made a tender to the Metropolitan Board for the sewage in 1860 and again in 1863, the plans not having undergone any modification, *Townsend* 1184-1187——The Board had nearly concluded arrangements with the company, *ib.* 1186.

Proposal of the company to start with an experimental capital of 30,000 *l.*, in order to demonstrate the value of the sewage, *Roberts* 1190, 1191——Estimate of 500,000 *l.* as an ample capital with a view to the utilisation of the whole of the sewage on the north side, including the works for placing the sewage on the land, *ib.* 1192-1202. 1216-1219.

Contemplated purchase or lease of 9,000 acres of land near the outfall at Barking, to which to apply the sewage, *Roberts* 1193-1196. 1203, 1204. 1240. 1251-1254——Calculation as to the cost or rent of the land, the value to be derived from the sewaged crops, and the profits eventually to be returned, *ib.* 1205-1214. 1221. 1236-1239——Proposal to give a peppercorn rent to the Metropolitan Board for some years, and afterwards such rental as the Board of Trade might determine was fair, *ib.* 1212-1214.

The total estimated cost of the works is 181,588 *l.*, *Brunlees* 1220——Way in which the sewage is proposed to be conveyed and distributed, *ib.* 1222-1227——Quantity of sewage to be applied, and mode of application; necessity in the first instance of a proper system of drainage, *ib.* 1229, 1230. 1241-1251. 1255, 1256——Facility with which the land may be had possession of, and a commencement made in the utilisation of the sewage, *Roberts* 1240. 1257-1259.

Letter from Mr. Roberts to the Main Drainage Committee, dated February 1859, giving an outline of the plan of the company, and showing the several respects in which the ratepayers would be benefited thereby, *App.* 330——Further communication from Mr. Roberts, dated 14 April 1859, containing sundry details in explanation of his scheme for utilising the sewage in a liquid state, *ib.* 330-332——Further communications from Mr. Roberts to the Metropolitan Board in August and November 1856, and in January 1860, *ib.* 332-334.

Copy of tender submitted by the secretary of the company, dated 5 July 1860, *App.* 334, 335——Copy of a draft agreement between the Metropolitan Board and the company for the use of the sewage, *ib.* 335, 336.

Sundry communications between the company and the Board in 1860, 1861, and 1862, with reference to the final concession of the sewage to the company, and the postponement thereof from time to time, *App.* 336-339——Exception taken by the company to the contemplated grant of the concession of the sewage to Messrs. Napier & Hope, *ib.* 337.

Grounds on which it is submitted that the company have a prior claim as compared with any scheme brought suddenly forward, *App.* 337, 338——Circumstances upon which expectations have been formed by the company that the concession would be granted to them, *ib.* 338.

LONDON SEWAGE UTILISATION COMPANY—continued.

Communication from the secretary of the company to the Metropolitan Board dated 7 May 1863 declining on the part of the company to submit any further tender or proposals for dealing with the sewage, but stating the willingness of the company to abide by their former proposals, if none so advantageous be laid before the Board, *App.* 338,339.

Extract from a report of the committee of the whole Board on the main drainage of of the metropolis, in which it is submitted that an arrangement on the basis of the propositions of the company might with advantage be adopted, *App.* 441.

Particulars supplied to the Main Drainage Committee of the Board in 1859, together with letter from Mr. Brunlees, explanatory of the calculations upon which the scheme is based, *App.* 475. 478.

M.

M'Clean, John R. Communication from Mr. M'Clean to the chairman of the Metropolitan Board of Works, dated 8 August 1856, proposing the formation of an outfall sewer or conduit for conveying the sewage from the pumping stations at West Ham, through the agricultural districts of Essex, *App.* 292, 293——Proposition that the conduit be made available for the purposes of sewage irrigation throughout its entire length, until it reaches the German Ocean, *ib.* 293——Way in which it is proposed to bring the sewage of the southern district into the conduit on the north side, *ib.*——Estimate of 1,600,000 *l.* as the total cost of the work; willingness of responsible persons to undertake the work for this sum, *ib.*

Memorial of occupiers of land in the southern division of the county of Essex, in favour of the foregoing scheme for dealing with the metropolitan sewage, *App.* 293.

Approval of the plan by Sir Morton Peto, and offer by him in November 1856 to execute it for a fixed sum, *App.* 294. 296, 297.

Notice inserted in the papers in November 1856 as preliminary to an application to Parliament in the then ensuing Session; details therein relative to the proposed scheme, *App.* 294, 295.

Letter from Mr. M'Clean to the chairman of the Metropolitan Board, dated 2 December 1856, in defence of his scheme against certain objections raised against it by the latter, as having been formed upon erroneous impressions, *App.* 297, 298.

M'Cormick, William (Member of the House), Samuel Cokes Ridley, and Joseph Cleaver.—(Analysis of their evidence.) (*Mr. Ridley.*) Has had many years' experience as a contractor, 5379——Employed Mr. Cleaver and Mr. Sewin, of Boston, to make the calculations on which he based his tender for the first portion of the low level sewer and embankment, 5380——(*Mr. Cleaver.*) Is a measuring surveyor, and made the estimates referred to by Mr. Ridley, 5381–5383——(*Mr. Ridley.*) The tender of witness was the lowest, and there were two others lower than the tender of Mr. Furness, 5384–5390——Witness was declared the contractor, but an objection was made by the Metropolitan Board to one of his sureties, and to his own practical experience; offer hereon by witness to deposit the full amount of the security, namely 20,000 *l.*, and to send in two more sureties, 5391–5402.

Explanation of the circumstances under which Mr. M'Cormick, having made an error in his own tender, eventually became associated with witness's contract, and brought in his own responsibility and reputation as a security for the efficient performance of the works, 5403–5406——The tender of Mr. Furness, though 25,000 *l.* in advance of witness's contract, was ultimately accepted, 5405, 5406. 5567.

Witness also tendered for the outfall reservoir on the north side, in which case Mr. Furness got the contract, though there was a lower tender, 5407–5412——This reservoir is not yet finished, there being a good many men still at work upon it, 5413–5417. 5580. 5584–5589——Understanding as to 500 *l.* having been paid to Mr. Furness in excess of the contract price for the reservoir, 5418, 5419——Witness has also heard that the reservoir has not been carried to the specified depth, 5420, 5421. 5580, 5581——Statement as to a coffer dam not having been formed at the reservoir, as contemplated under the contract; witness added about 16,000 *l.* to his estimate on account of this requirement, 5422–5439.

(*Mr. M'Cormick.*) Witness explains the circumstances under which he joined Mr. Ridley in his contract for the first section of the Thames embankment and low level sewer; he has carried out works of much greater magnitude and difficulty, 5440–5443. 5563, 5564——The error in witness's tender was caused by his having estimated for a double coffer dam, which was not at all necessary, 5440. 5556–5563.

(*Mr. Ridley.*) Clear understanding given to intending contractors that the materials for the embankment were to be obtained from the Thames conservators, at the expense of the former, 5444–5449——(*Mr. Cleaver.*) Calculation that each tender would have been 69,000 *l.* less, but for the understood necessity of taking the Thames mud and gravel, and that this saving, together with the receipts for allowing rubbish to be shot, *M'Cormick, W., S. C. Ridley, and J. Cleaver.*—(Analysis of their Evidence)—*continued.*

amounts to 80,000*l.* on the part of the contractor, 5451–5473. 5527–5534——Inferior character of this rubbish for the purpose of the embankment, as compared with Thames gravel, 5461. 5466–5468. 5535–5542——Statement as to the rubbish having been shot before the completion of the coffer dam, so that much is washed away, to the injury of the river, 5475–5485.

Great crowding of Fleet-street, and other thoroughfares, by the carts bringing the rubbish for the embankment, 5486–5488. 5543–5547——(*Mr. Ridley.*) As many as 740 loads have been shot in a day, 5489–5491——(*Mr. Cleaver.*) The price for the liberty of shooting is 6*d.* or 9*d.* a load, 5493, 5494——(*Mr. Ridley.*) Practice as regards addition to, or deduction from, the contract price, where deviations are made in the line of any of the sewers, as in the low level sewer on the south side, 5495–5502.

System generally of paying by a schedule of prices for extra works not included in the specifications, 5503–5507——(*Mr. M'Cormick.*) Definite sums are sometimes put down for extra works, the amount being deducted if the works are not executed, 5508–5511. 5565, 5566——(*Mr. Ridley.*) A sum of 10,000*l.* was set down for extra works at the reservoir on the north side, 5512——Opinion as to the small quantity of the embankment work done by Mr. Furness at the end of May, when he was paid 33,000*l.* on account, 5520——(*Mr. Cleaver.*) Estimate that when the 33,000*l.* was paid, the work done did not represent more than 10,000*l.*, 5521–5526.

(*Mr. Ridley.*) Witness tendered for the southern low level sewer, but declined to undertake the contract on account of the conditions relative to easement, 5548, 5549——In the matter of the northern low level sewer and embankment, witness was asked numerous questions by members of the board, and had some conversation with the engineer of the board on the subject of the coffer dam to be used, 5553–5555——The coffer dam is now being made, and is compulsory under the contract, 5568–5570.

Statement to the effect that although 10,000*l.* is allowed for a coffer dam in the estimate for the north side reservoir, this sum will not be deducted if the coffer dam be not ordered by the engineer to be made, 5571–5573. 5590–5593——Witness is not aware whether the Board of Works have applied to the Conservancy Board for supplies of Thames gravel, but rubbish has been used for a considerable time, 5594–5599——The contractor for the second section of the embankment is also using rubbish in lieu of Thames gravel, 5600–5602——Practice as to contractors for the sewers paying for severance of property and right of way, and as to the saving by deviation on to a high road, 5603–5612.

MAIN DRAINAGE WORKS:

1. *Final Adoption of the Main Drainage Scheme in* 1848.
2. *Estimate in* 1858, *as compared with the actual Cost.*
3. *System of separate Contracts, and Number still unlet.*
4. *Capacity of the several Sewers and Reservoirs.*
5. *Actual progress made with the Works.*
6. *Penalties for delay in Completion; their non-enforcement.*
7. *Check in regard to Payments on Account.*
8. *Practice with respect to extra Works*; *Payments on this Score.*
9. *Returns relative to the several Tenders and Contracts.*
10. *Returns of Expenditure, with Estimate of further Cost.*
11. *Scheme submitted by Mr. Moore in* 1858 *for an amendment of the Main Drainage System.*
12. *Suggestion by the Committee with reference to the Utilisation of the Sewage.*
13. *Incompleteness of the Committee's inquiry into the System of Works.*

1. *Final Adoption of the Main Drainage Scheme in* 1848:

The general scheme of the main drainage works was finally approved by the Metropolitan Board in 1858, *Bazalgette* 5110, 5111——The works were in the first instance designed piecemeal, and the plans were modified from time to time before they were finally adopted, *ib.* 5112.

2. *Estimate in* 1858, *as compared with the actual Cost:*

Preparation by witness in 1858 of an estimate for the entire scheme, based upon the then value of materials and workmanship, and amounting to 2,800,000*l.*, *Bazalgette* 5114–5118——Increased powers taken for borrowing 1,115,000*l.* in addition to the original estimate, in consequence of the great advance (about thirty per cent.) since 1860, in the value of materials, *ib.* 5117–5120——Views of Sir Robert Stephenson and Sir William Cubitt in approval of the joint estimate, and report of Mr. Haywood and witness in 1854 relative to the works on the north side, and concurring in an estimate of 3,000,000*l.* for the entire scheme, *ib.*——The powers first taken were for 3,000,000*l.*, *ib.*

Statement

MAIN DRAINAGE WORKS—continued.

2. *Estimate, in* 1858, *as compared, with the actual Cost*—continued.

Statement that witness's estimates for twenty contracts let up to 1863 were 2,725,983*l.*, and the works were let at 2,752,327*l.*; closeness of this approximation to the real cost, *Bazalgette* 5122–5125——The rise in price occurred after one of the contracts had been let, and the contractor, Mr. Moxon, was ruined, but the Metropolitan Board did not suffer, *ib.* 5126–5129——Further information explanatory of the increased cost of the works beyond the original estimate of 3,000,000*l.*, *ib.* 5267–5273.

3. *System of separate Contracts, and Number still unlet:*

Division of the scheme into a number of contracts of convenient size, *Bazalgette* 5113, 5114. 5121, 5122——Three more contracts have been let since this time last year, in addition to twenty contracts previously let, and there are still about three remaining to be let, *ib.* 5125.

Probability of there being five or six more separate contracts to be let, instead of three more, *Bazalgette* 5827.

4. *Capacity of the several Sewers and Reservoirs:*

Statement of the discharging power of the several intercepting sewers on the north and south side respectively, *Bazalgette* 5144——Explanation as to the data by which the Board were guided in estimating the size of the sewers and reservoirs, and the increased provision to be made for future augmentations, *ib.*——Allowance made for a maximum flow during certain hours, the flow varying very much during the twenty-four hours, *ib.*

5. *Actual Progress made with the Works:*

Expectation that the works both on the north side and the south side will be completed this year, with the exception of the Low Level Sewer on the north side, *Bazalgette* 5130. 5282, 5283——Actual progress made with the different works; considerable portion of the scheme already in operation, *ib.* 5135. 5274–5283.

6. *Penalties for Delay in Completion; their Non-enforcement:*

The Board have not yet enforced any penalties for delay in completion; discretion desirable to be exercised by them in this respect, *Thwaites* 5871–5875.

Return of the amount of penalties, according to each contract, which were to be imposed for delay in completing the works, *App.* 493——No fines have been received by the Board, *ib.*

7. *Check in regard to Payments on Account:*

Careful manner in which the work of the contractors is measured and checked by witness's staff before payments are made, *Bazalgette,* 5295–5299.

8. *Practice with respect to Extra Works; Payments on this Score:*

System in contracts generally of paying by a schedule of prices for extra works not included in the specifications, *Ridley* 5503–5507——Definite sums are sometimes put down for extra works, the amount being deducted if the works are not executed, *McCormick* 5508–5511. 5565, 5566.

Information as to the large items estimated in the different contracts for extra works or unforseen contingencies, and as to the practice of payment in such cases, *Bazalgette* 5224–5236——Explanation of the system in regard to the addition to each contract, under the main drainage scheme, of a certain sum for extra works and for provisional quantities, payment being contingent upon the additional work performed, *Thwaites* 5876–5879——Details as to the amount allowed for extra works under particular contracts, and as to the payments made in addition thereto, *ib.* 5880–5890.

Statement of the amount allowed and the amount paid in each case for extra works, and the amount paid upon each contract over and above the amount of the contract, *App.* 495, 496.

9. *Returns relative to the several Tenders and Contracts:*

Return of the the tenders for the main drainage works, showing the names of the persons who tendered, the amounts of the tenders, and also the names of the sureties proposed, *App. p.* 479–484——List of all the tenders, showing the name, the amount for which each tender was accepted, and the names of the sureties accepted, *ib.* 485–488.

Return showing the time when each contract was entered into, and when the works under that contract were to be completed; also the time when the works were actually finished and delivered to the Board; also the amount actually paid on each contract, including extra work, with the name of the contractor, and the amount of the contract; also similar information as to contracts still in hand, *App.* 489.

Statement compiled from Returns furnished by the Metropolitan Board, containing further particulars relative to the contracts for the main drainage works, and distinguishing between the works completed and the works in progress, *App.* 494, 495.

MAIN DRAINAGE WORKS—continued.

10. *Returns of Expenditure, with Estimate of further Cost:*

Return of the amount which has been applied to the main drainage works in each year since the year ending 25 March 1860, inclusive, *App.* 491——Statement of the sums assessed (or levied) by the Metropolitan Board of Works on the several parishes, districts, &c., for the years 1856 to 1864 inclusive, on account of the main drainage, *ib.* ——Return of amounts borrowed by the Metropolitan Board of Works since its formation for main drainage works, showing also the amount repaid, *ib.* 492——Return of the estimated amount which will be required to complete the main drainage works, distinguishing the amount which will be required to finish the embankment, *ib.*

11. *Scheme submitted by Mr. Moore, in* 1858, *for an Amendment of the Main Drainage System:*

Suggestions by Mr. Moore, in August 1858, as to the best mode of arranging the drainage of the metropolis, with a view to the utilisation of the sewage, *App.* 315–317 ——Proposal by Mr. Moore that the North Upper Level Intercepting Sewer be constructed in such a manner as will be available to supply the occupiers of land with sewage by gravitation, *ib.* 315 *et seq.*——Paper, dated 30 November 1858, containing a detailed statement of facts, and of the data upon which the scheme is supported, *ib.* 318-323.

12. *Suggestion by the Committee with reference to the Utilisation of the Sewage:*

The completion of the outfall sewage should at the earliest possible moment be followed by the adoption of a system which may convert the sewage from a nuisance into a permanent and increasing source of agricultural fertility, *Rep.* v.

13. *Incompleteness of the Committee's inquiry into the System of Works:*

Inability of the Committee to complete their inquiry into the measures being carried out for diverting the sewage of the metropolis, *Rep.* vii.

See also *Abbey Mills Pumping Station. Bermondsey Branch Sewer. Deviations (Line of Sewers). Engines*, 2. *Middle Level Sewer. Northern High Level Sewer. Northern Low Level Sewer. Northern Outfall Reservoir. Northern Outfall Sewer. Pumping Stations. Sewers. Southern High Level Sewer. Southern Low Level Sewer. Thames Embankment and Northern Low Level Sewer. Western Sewers.*

Mains for Conveyance of Sewage. See *Pipes and Mains.*

Malahide Bay Sands. Illustration in the case of the Malahide Bay Sands of the practicability of the reclamation scheme of Messrs. Napier and Hope, *Hemans* 500. 630, 631.

Malvern (Worcester). Quotation by Mr. Shepherd of several statements as to the excellent effects of sewage as applied to some farms near Malvern, *App.* 345-347.

Manchester. Reference to a certain proposition for utilising the excrementitious matter of Manchester, by converting it into a solid manure, *Taylor* 3945.

Putrified character of the deposit in the Manchester rivers, *Rawlinson*, 4064–4066—— Statement as to the Manchester Corporation spending about 20,000 *l.* a-year in emptying cesspools, &c., about one-half of which is received back again from purchasers of the material, *ib.* 4095-4067. 4101.

Reference by the Committee to the large expenditure by the local authorities in emptying the cesspits and removing the contents to the land; return of fifty per cent. received upon the sale of the material, *Rep.* vi——Saving to the town if there were a system of removing the sewage in a liquid state, *ib.*

Mangel Wurtzel. Opinion that town sewage cannot be beneficially applied to mangel wurtzel or turnips, *Johnson* 2237–2411——Belief that sewage would be very useful for the growth of mangel wurtzel, *Whitehead* 2912——Success of sewage applications by witness to mangel wurtzel, *Mechi* 3384–3386——Satisfactory experience of the Earl of Essex in regard to the application of sewage to mangel wurtzel, *App.* 345, 346.

Manufactories, Refuse from. See *Rivers, &c.*

MANURE:

Less prospect of profit by solidifying sewage than by applying it in a liquid state, *Thwaites* 58–60. 222, 223——Conclusion as to the sewage being remunerative only when applied in a liquid state, *Sir C. Fox* and *Mr. Smith* 1286, 1287. 1553. 1568——Failure of the experiments at Leicester for extracting a solid manure from the sewage, *Smith* 1559; *Taylor* 3914; *Rawlinson* 4031–4034; *Way* 4901–4903——The fertilising matter is all in the liquid, *Shepherd* 1617.

Statement

MANURE—continued.

Statement as to the sewage being of much greater value as a manure when applied in a liquid than in a solid state, *Ellis* 1797–1801. 1804. 2415, 2416——Impracticability of extracting from the sewage all the manurial property, and drying it, so that its value in a solid state is quite theoretical, *ib.* 2412–2414——Reference to a statement by Professor Way, as to the importance of extracting and drying the fertilizing substance in the sewage, *ib.* 2419–2421——Statement as to witness's practice of liquifying manure before application, and as to the mode of application, *Mechi* 3337. 3412–3416. 3421, 3422, 3436–3441.

Advantage if the sewage of houses could be applied in a less diluted state, *Walker* 3620. 3673, 3674——Disapproval of any system for solidifying town sewage, *ib.* 3720, 3721——Obstacle to getting rid of the evil by converting the solid portion of the sewage into manure, *Taylor* 3894, 3895——Reference to the value of all attempts hitherto to deoderise sewage, and make a portable manure to rival guano, *Rawlinson* 4231, 4232.

Necessity of using the sewage of towns in a liquid form upon land, as the only alternative if it be excluded from the rivers, *Way* 4709–4712. 4754——Impracticability of producing, at a profit, dry manure from sewage, *ib.* 4749, 4750——Advantage both to the farmer and the landlord if there were increased supplies of manure at a less cost, *ib.* 4760–4766.

Doubt as to there being anything like the quantity of manure used in England which is said to be used in France, *Way* 4761–4771——Great insufficiency of the present supply of manure for the purpose of an improved state of agriculture, *ib.* 4766——Probable quantity of each kind of manure used in this country, *ib.* 4772–4784.

Conclusions of the Committee as to the manurial value of sewage, and as to the practicability of applying it as a liquid manure with profitable results, *Rep.* v.

See also *Agriculture.* *Artificial Manure.* *Farm Yard Manure.* *Foreign Manure.* *Kirkman, C. F.* *Thudichum, Dr.* *Value of Sewage.*

Manurial Ingredients of Sewage. See *Value of Sewage.*

Maplin Sands (Essex) Reclamation Scheme. See *Metropolis Sewage and Essex Reclamation Company.*

Market Gardens. Objection to applying the sewage to a rich class of land as about Fulham, *Smith* 1543–1546——Town sewage might be advantageously applied to market gardens, *Mechi* 3388.

Marylebone. Resolutions agreed to at a public meeting of the ratepayers and inhabitants as to the value of the metropolitan sewage, and the best mode of applying it to land, *App.* 451.

Mechi Alderman. (Analysis of his Evidence.)—Has for may years applied liquid manure to land, 3313——Constant escape of some of the sewage through the land into the streams, although it is a very stiff soil, 3314–3332. 3344–3349. 3373–3376——Character of the sewage used by witness as compared with the London sewage, 3319–3325——Effect of a preliminary filtration of the London sewage in preventing any pollution of the streams after the application to the land, 3326. 3332. 3383——Greater pollution of streams accordingly as larger streams of sewage are applied, 3327–3332. 3349.

Application of the sewage over witness's land by hose and jet; advantage of this plan over the system of open gutters, 3333–3336. 3354, 3355. 3375——Great value attached to sewage as a manure, more especially for grass lands, 3337–3343. 3350–3352——Illustration of the value attached by witness to water for liquifying guano, &c.; expense incurred on this score, 3337. 3412, 3413. 3416. 3336–3441——Practice as to the crops to which witness applies the sewage; its value in improving grass land for subsequent grain crops, 3338–3343. 3397–3409——Witness has found by experience that sewage is good fo every crop, 3338. 3387.

Valuable effect of direct sewage application to cereal crops; care necessary in application, 3343. 3394–3396——Varying effects of different soils in absorbing the manurial properties in sewage, 3344–3347. 3370, 3371. 3375–3381——For grass land there should be about four or five dressings in the year, at the rate of 100 tons for each dressing per acre, 3348. 3353——Belief that farmers would in time gladly avail themselves of town sewage, and would be ready to pay from 2*d.* to 3*d.* a ton for it; illustration in witness's case 3350–3353. 3336–3441.

Absence of any polluting effect upon rivers when only a limited quantity of sewage or of manure finds its way into them, 3352, 3353——Nor are fish destroyed where the escape of manure from the land is but moderate, 3353——Conclusion that the whole of the London sewage may be distributed over an extended area, in moderate dressings, so as not to pollute the streams, or cause any inconvenience, 3353. 3382, 3383——Circumstances

Mechi, Alderman. (Analysis of his Evidence)—*continued.*

stances under which open gutters are a very advantageous mode of distribution, 3355 3357——Considerable adulteration in artificial manures, 3359——Question as to bone being better as a manure, with or without the extraction of the fat by boiling, 3360-3363.

Information relative to the sewage filtration works at Croydon, and their effect upon the sewage, 3364-3369——Greatly increased value of some pasture land of witness in consequence of sewage applications, 3371, 3372. 3410, 3411——Character of the drainage of witness's farm adverted to with reference to the liquid manure or sewage applications, 3373-3383. 3418-3420——Success of sewage applications by witness to mangel wurtzel, 3384-3386——Also to turnips, 3387. 3397——It might also be very advantageously applied to market gardens, 3388.

Further particulars relative to the pipes, tanks, &c. for the reception and distribution of the sewage over witness's land, 3389-3391. 3421-3426——Value of the sewage in winter, or in wet weather, as well as in summer, 3392, 3393——Witness finds the sewage chiefly useful in the care of grasses, and as a preparation for subsequent crops, 3397-3409——Further statement as to witness's practice of liquifying manure before application, and as to the mode of liquidation, 3412-3416. 3421. 3424.

Dissent from the views of Mr. Cuthbert Johnson as to the whole of the sewage matter being absorbed by the crop or soil, 3427, 3428——Excellent effect upon land by the natural filtration of water through it, 3429-3431——Importance of the aëration of the soil; defect of witness's system of drainage in this respect, 3429-3431. 3433-3435. 3442.

Medlock River. Peculiarly foul state of the River Medlock; aggravation of the pollution accordingly, as water closets are more extensively used in Manchester, *Rawlinson* 3997. 4000. 4058, 4059.

Meters (*Supply of Sewage.*) Way in which the sewage might be measured if supplied to farmers, *Mr. Smith* and *Sir C. Fox*, 1528-1536——Intention under witness's plan to supply the sewage by meter, the farmers laying down the sub-pipes, *Ellis* 1913-1917. 2013. 2019.

METROPOLIS SEWAGE AND ESSEX RECLAMATION COMPANY:

1. *Outline of this Scheme, for Utilizing the Sewage from the North Side of the River.*
2. *Proposed Culvert for the Conveyance of the Sewage to the Maplin Sands.*
3. *Embankment Walls and Works at the Maplin Sands; Explanation and Defence thereof.*
4. *Objections to the Proposed Embankment as being of an exceedingly difficult and costly Character.*
5. *Intended Lifting of the Sewage and Distributing by Gravitation.*
6. *Arrangements for lateral Distribution on the way to Maplin Sands.*
7. *Time required for the Construction of the Works.*
8. *Considerations as to the Sufficiency of the Reclaimed Area.*
9. *Process of Fertilization of the Sands, and of subsequent Cultivation.*
10. *Question of a Nuisance being created.*
11. *Apprehended Injury to the outside Navigation.*
12. *Cost of the Scheme considered.*
13. *Consideration of the Question of Profit and of the Terms offered to the Ratepayers.*
14. *Guarantee for the Execution of the Works.*
15. *Details supplied to the Metropolitan Board on the Score of Plans, &c.*
16. *Correspondence and Papers containing sundry particulars of the Scheme as submitted to the Board.*
17. *Previous Scheme in* 1852 *for reclaiming the Maplin Sands, no action having been taken under the Act then obtained.*
18. *Reports of Mr. Hopkins and Mr. Hemans respectively.*
19. *Objections on the part of Mr. Finch in respect of Foulness Island.*
20. *Objections by Mr. Shepherd.*
21. *Objection by the Westminster Board of Works.*
22. *Favourable Opinion entertained of the Scheme by the Metropolitan Board.*
23. *Circumstances under which the Scheme eventually dropped.*

1. *Outline of this Scheme, for Utilizing the Sewage from the North Side of the River:*

roposal of Messrs. Napier and Hope for utilizing in a liquid form the sewage from the north side of the river by application to about 20,000 acres of reclaimed land on the coast of Essex; terms involved in this tender, *Thwaites* 70-75——By this plan it was also proposed to distribute right and left on the way to the Maplin Sands, *ib.* 74. 101-104. 299, 300.

Intention

METROPOLIS SEWAGE AND ESSEX RECLAMATION COMPANY—continued.

1. *Outline of this Scheme, &c.*—continued.

Intention of the promoters of the scheme to deal with the sewage of the north side only, *Hemans* 419——It is proposed to reclaim 8,000 acres on the Dengie Sands, and 12,000 acres on the Maplin Sands, *ib.* 429, 430. 453, 454——Reasons for the recent determination of the promoters to confine the reclamation scheme to the Maplin Sands; expected larger use by farmers on each side of the culvert, *Hope* 573-578. 602-606.

Further reference to the abandonment of the use of the Dengie Flats; report of Professor Way on these sands adverted to, *Hemans and Hope* 742-752——It is proposed to take all the sewage that the Metropolitan Board are prepared to give, the storm overflow being separately provided for by the Board, *Hope* 903-908. 919-923.

Great modification made in the plan this year by the promoters, *Hopkins* 1061-1063.

2. *Proposed Culvert for the Conveyance of the Sewage to the Maplin Sands:*

It is intended to construct a culvert, ten feet in diameter, for carrying the sewage from Abbey Mills; the length would be forty-four miles in all, *Hemans* 419-422——Proposed uncovered branch culverts on reaching the River Crouch, *ib.* 422-424——Uniform slope at which the culvert would be carried, the principle of gravitation being observed throughout, *ib.* 434-441——Necessity of an Act of Parliament in order to make the culvert, *Hope* 661.

Shape of the culvert; its similarity to that from London to Barking, *Hemans* 772——Consideration of the question whether the culvert should not take a different and longer course; objections thereto, *Hope and Hemans* 796-813——Probability of the culvert being covered throughout under the amended plan now put forth by the promoters, *Hemans* 828-831.

3. *Embankment Walls and Works at the Maplin Sands; Explanation and Defence thereof:*

Information relative to the embankment work proposed to be built upon the Maplin Sands; belief that a solid foundation may be procured within a reasonable depth, *Bazalgette* 119-133——Provision made against the wall being swallowed up in quicksands, *ib.* 121-124——Reference to the views of Mr. Hopkins, as to the impracticability of the proposed embankment wall; dissent therefrom, *ib.* 129-133. 144——Experience of witness in the building of sea walls, *ib.* 130. 359-363.

Witness understood that the retaining walls or embankment was to be built within low-water mark, *Thwaites* 134-136——Further explanation as to the mode of formation of the proposed embankment for reclaiming the Maplin Sands, *Bazalgette* 275-286.

Extent of nearly twenty-six miles of wall necessary for enclosing the 20,000 acres of sands; there would also be cross walls, *Hemans* 449-460——Way in which the streams running on to the sands from Foulness Island would be dealt with, *ib.* 461-464——Growing accummulation of slob or deposit on the Dengie and Maplin Flats, the whole of the coast there being gradually warping up, *ib.* 462. 465-477——Circumstance of the whole of Foulness having formerly been below high-water mark, *ib.* 465, 466. 473, 474.

Position and depth of the present embankment walls, and way in which protected by the sands, as compared with the walls proposed by witness, *Hemans* 478-491——The sea would be at an average depth of from eleven to twelve feet along the proposed wall, *ib.* 489——For short distances there might be as much as twenty feet of water, *ib.* 490.

Evidence opposed to the view that the sea would loosen the sand beneath the proposed embankment, and that the embankment would subside, *Hemans* 492-501——Fallacy involved in the conclusions of Mr. Hopkins, *ib.* 492——Witness does not consider these sands to be quicksands; but, even if they were, this would not render the scheme at all impracticable, *ib.* 493-497. 507.

Further statement as to the height, breadth, and depth of the embankment wall, *Hemans* 502-504——Materials of which it would be composed, and way in which these would be put together, *ib.* 505, 506——Even if the sands were very deep, it would not interfere with the mode of construction, *ib.* 507.

With regard to the great depth of water outside the embankment in some places, there is no probability of its coming in through the sand under the embankment, *Hemans* 537, 538——System of catch-water drains with outlets and valves for getting rid of any surplus water, *ib.* 539. 628——With regard to Mr. Bazalgette's report upon the scheme, it was not found necessary by him to make investigations on the spot, *ib.* 542, 543.

Further statement as to the mode of dealing with streams now running across the Maplin Sands, *Hemans* 668-672——Opinion of Mr. M'Cormick, who constructed the works at Loughs Foyle and Swilly, as to the facility of executing the works now proposed by Messrs. Napier and Hope, for utilising the London sewage on the Maplin Sands, *ib.* 735——Further evidence as to the durability of the embankment wall, and its sufficiency to keep out the sea, 773-776. 791, 792——Way in which it is proposed to place the stones upon the embankment, *ib.* 777-779.

METROPOLIS SEWAGE AND ESSEX RECLAMATION COMPANY—continued.

4. *Objections to the proposed Embankment as being one of an exceedingly difficult and costly Character:*

Witness was employed in 1862 by Mr. Finch, the owner of the greater part of Foulness Island, to examine the scheme of the Metropolis Sewage and Essex Reclamation Company; made a careful investigation of the scheme, *Hopkins* 929–940——Adverse conclusion arrived at by witness as to the practicability and cost of the scheme, with reference more especially to the proposed embankment walls; grounds for this conclusion, *ib.* 941. 960 *et seq.*——Computation that about sixteen miles of the embankment wall would be in deep water; about nine miles being in twenty feet of water, *ib.* 960–969——Conclusion as to there being a depth of forty feet of sand on the Maplin Flats, *ib.* 970, 971.

Statement as to the height and base necessary for the proposed walls, *Hopkins* 972–975——Particulars relative to the present embankment walls in Foulness Island; no inference can be drawn therefrom as to the stability or cost of walls on the Maplin Sands, *ib.* 973–984. 1081–1084——Exceedingly exposed situation of the proposed walls, *ib.* 981. 984–986. 1094——Considerable difficulty as to the materials for the proposed embankment; very heavy cost on this score, *ib.* 988–1009. 1029–1035——Difficulties and interruptions to be encountered from the tide in constructing the embankment, *ib.* 993–995. 1008. 1092, 1093——Natural process by which warping takes place, and a mud deposit is formed; great slowness of this process, *ib.* 1010–1014——Necessity of arrangements for keeping the inlets on Foulness Island supplied with water from the sea; there are no outlets across Foulness Sands, *ib.* 1038–1043.

Further statement as to the scheme for reclaiming the Maplin Sands being objectionable, on account of the great difficulty of the works and their exceedingly costly character, *Hopkins* 1088–1094.

5. *Intended Lifting of the Sewage, and Distributing by Gravitation:*

The level to which the sewage is to be worked by the Metropolitan Board, and at which it would enter the culvert, is five feet above Trinity high water-mark, *Hemans* 419–420——Arrangement in regard to lifting the sewage, where necessary, along the line of the culvert; expense on this score, *ib.* 662–667——Covered reservoir contemplated at Abbey Mills in connection with the scheme for the reclamation of the Maplin Sands, *ib.* 767, 768——Statement as to the proposed use of steam power, and of drains for supplying the lateral lands along the culvert, *Hemans and Hope* 736–741.

Very small area between Abbey Mills and Maplin Sands, over which the sewage could be distributed by gravitation, without pumping, *Hopkins* 1054–1056. 1063–1065.

6 *Arrangements for Lateral Distribution on the way to Maplin Sands:*

Evidence with reference to the intended distribution of sewage from the proposed culvert to Maplin Sands on its route thither, *Thwaites and Bazalgette* 74. 101–104. 299, 300. 338–340. 357, 358——It has been shown that it would be feasible to irrigate the lands alongside the proposed culvert between the Abbey Mills and Maplin Sands, *Thwaites* 392, 393.

Lateral supply to the adjoining farms where the culvert is above ground, it being, however, in tunnels about three-fourths of its length, *Hemans* 442–446——Information as to the proposed system of pipes and gutters in connection with the culvert, *Hope* 555–557. 563–567. 603–606. 789, 790.

Statement that though the culvert will be in tunnels for three-fourths of its length, it will still command, where above ground, 30,000 acres by gravitation; larger distribution expected on this score than was at first contemplated, *Hemans* 573–578. 602–620——Means by which distribution may be effected where the culvert is underground; large area thus to be dealt with, *ib.* 612, 613. 860——It would be a matter of subsequent arrangement whether the sewage on each side of the culvert run in open gutters or through pipes, *ib* 909.

7. *Time required for the Construction of the Works:*

In three or four years the works would be completed, *Hope* 848–850.

8. *Considerations as to the Sufficiency of the Reclaimed Area:*

Very large application of sewage per acre under the plan of Messrs. Napier and Hope; doubt, however, whether any nuisance would be created by reason of the comparative smallness of the area, *Thwaites* 100–112——Grounds for concluding that the amount of liquid sewage proposed to be placed on the reclaimed shore land of Essex is not excessive, *Bazalgette* 113–118——Way in which the surplus sewage not required for distribution *en route* to Maplin Sands, during a portion of the year, should be got rid of, *ib.* 379–381.

Calculations

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8. *Considerations as to the sufficiency of the Reclaimed Area*—continued.

Calculations as to the quantity of sewage to be distributed over the reclaimed land, and as to the sufficiency of an area of 12,000 acres for absorbing it, *Hemans* 508–516. 520–525. 573–578——Ample surface upon which to raise crops when the Maplin Sands are enclosed, *ib.* 627–629——Statement as to there being ample means and an ample area for utilising the whole of the sewage, *Hope* 872, 873. 910–923——Sufficiency of an area of 12,000 acres, *ib.* 872, 873.

9. *Process of Fertilization of the Sand, and of subsequent Cultivation:*

Conclusions as to the fertilising action of the sewage on the sand, *Hope* 526–536——The promoters would probably themselves farm part of the land, that is, by growing grass crops and selling them to the farmers, *ib.* 639–643. 753–756——Six or seven grass crops may be had in the year, *ib.* 639. 920——It is proposed to turn all the land into dairy farms, *ib.* 642——Simple process necessary in preparing the land for the first crop, *ib.* 644–647.

Belief that the surplus water removed from the reclaimed land would not contain any valuable manurial properties, *Hemans* 761–763——Absence of difficulty in regard to the farmers at the Maplin Sands objecting to take more than a limited quantity of sewage, *Hope* 783–786. 794——Advantage of the Maplin sands over any lands nearer London on which to apply the sewage. *ib.* 795. 807, 808.

Further evidence as to the absorption of the manurial properties of the sewage by the grass crops, and as to the depth to which the filtered water will sink into the sand, *Hope* 890–898. 900. 902. 910–920——It is expected that the tillage will sink to the level of the water in the ditches, *Hemans* 899.

Danger of the manurial properties of the sewage being carried through the sand, *Hopkins* 1045, 1046——Belief as to the sea percolating under the embankment into the reclaimed space, thereby hindering the process of reclamation, *ib.* 1049–1051.

10. *Question of a Nuisance being Created:*

If any nuisance were experienced from the sewage being exposed in the branch culverts they could easily be covered, *Hemans* 425–428——Improbability of any nuisance from the proposed way-side distribtion from the culvert, *Hope* 602–606——Few habitations near the culvert where uncovered, *Hemans* 769–771——The culvert would probably be covered throughout, so that nuisance could not arise from it, *ib.* 828–831.

It was proposed to carry the sewage across Mr. Finch's land in Foulness Island in an open culvert, from which it was apprehended great nuisance would arise, *Hopkins* 933–935——Amount of the population at Burnham, Foulness, &c., which would suffer a nuisance from open culverts, *ib.* 1052, 1053.

11. *Apprehended Injury to the Outside Navigation:*

Character of the navigation outside the Maplin Sands; apprehended endangering of West Swin channel if the embankment be carried out, *Hopkins* 977–980. 1017–1021.

12. *Cost of the Scheme considered:*

Total of 2,000,000 *l.* as the cost of the scheme submitted by Messrs. Napier & Hope; careful inquiry by the Main Drainage Committee on this subject, *Bazalgette* 145–149.

The estimated cost of the entire works is 2,000,000 *l.*, including the enclosure of the sands, *Hemans* 431–433——Estimate of 1,217,382 *l.* as the cost of the culvert, *ib.* 431, 432.

Considerable reduction in the original estimate of cost, on account of the abandonment of the reclamation of the Dengie Flats, *Hope* 579–581——Explanation relative to the amount of share capital and of debentures proposed to be raised, the interest upon the latter, and the probable return upon the former, *ib.* 582–601——Outlay necessary for farm buildings; how this would be provided, *ib.* 647, 648.

Explanation as to the Lands Improvement Company, or Lands Securities Company, and the International Financial Association being willing to provide the capital for the scheme on certain terms, *Hope* 647–657. 673–680. 740. 855–859——The capital would be about 1,600,000 *l.*, exclusive of the amount for farm buildings or plant which would be paid off, *ib.* 658, 659——The promoters are prepared, if necessary, to proceed without the aid of the Financial Company, *ib.* 675. 680–682——Explanation as to the promoters having withdrawn the financial portion of the scheme, *Napier* 702–706.

Evidence in support of the conclusion that the proposed works would cost a much larger sum than has been estimated, on account of their immense difficulty, that is, at the Maplin Sands, *Hopkins* 960 *et seq.* 1027–1037. 1088–1094——Estimate of the total cost of the embankment; large excess beyond the estimate of Mr. Hemans, *ib.* 1027–1037.

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13. *Consideration of the Question of Profit, and of the Terms offered to the Ratepayers:*

Half the profits are offered for the sewage, *Hope* 540, 541——Degree of uncertainty attaching to the value of the reclaimed land, and the rental to be obtained from it; steady increase anticipated after a time, *ib.* 589–601——Experience of the Craigentinny meadows adverted to in support of the conclusion that a rental of 40 *l.* an acre may be obtained, and a total profit of from 30 to 40 per cent. returned, *ib.* 633–638. 757–760——Probable period in which the anticipated large profits will be realised and divisable, *ib.* 676–679.

Explanation as to the promoters or aiders of the scheme not having offered a fixed rent for the sewage, instead of a share of the profits, though feeling confident that the latter would be large, *Hope* 698–701. 715–724——Sufficiency of a rental of 20 *l.* an acre to give a return of 20 per cent. to the shareholders and the ratepayers, *ib.* 814–821. 861–863——The sewage of the south side would be available for a separate revenue, *ib.* 822, 823.

Witness declines to offer a given price for the sewage; grounds for this refusal further considered, *Hope* 834–854. 864–866——Limited expense in connection with clearing the sluices at the Maplin Sands, *ib.* 881——The land being obtained for nothing is a material element in the financial calculation, *ib.* 889.

It is computed that the cost of lifting and conveying the sewage from the outfall to its place of application will be one-fifth of a penny per ton, *Hemans* 924, 925.

Conclusion that the whole sewage of the north side of the Metropolis cannot be utilised by the proposed scheme, and that the scheme would not be profitable either to the promoters or the ratepayers, *Hopkins* 1057–1068——In Foulness Island the land does not let for more than 40 *s.* an acre, *ib.* 1058.

14. *Guarantee for the Execution of the Works:*

Doubt as the propriety of the promoters being required to give any material guarantee for carrying out the scheme, beyond the large Parliamentary deposit required, *Hope* 683–685——Amount of the deposit; its liability to forfeiture, *ib.* 686–688——Willingness of the promoters not only to forfeit the deposit money but to consent to a forfeiture of works in case of failure, *ib.* 867–871.

15. *Details supplied to the Metropolitan Board, on the score of Plans, &c.:*

Deposit of the required plans in the case only of the tender of Messrs. Napier & Hope, *Thwaites* 270–272——Explanation as to it not having been possible recently to supply the Metropolitan Board with further details of the scheme, *Napier & Hope* 544–550——Statement as to the promoters having complied with the conditions required by the Metropolitan Board in their advertisement of May 1863, *ib.* 689–697.

Reference to the question as to maps and sections having been furnished by Messrs. Napier & Hope; alteration in their original plan adverted to hereon, *Ellis* 2067–2071.

16. *Correspondence and Papers containing sundry Particulars of the Scheme, as submitted to the Board:*

Papers explanatory and in support of the tender from the Honourable William Napier and Mr. Hope for the disposal of the sewage discharged by the main outfall sewers on the north side, *App.* 423–429.

Further letter from Messrs. Napier & Hope, dated 29 April 1864, in explanation of their scheme and its advantages, and of the intended modification of the original plan by not confining the distribution to the Maplin Sands, *App.* 462–466.

17. *Previous Scheme in* 1852 *for reclaiming the Maplin Sands, no action having been taken under the Act then obtained:*

With regard to the scheme having been first submitted to the Metropolitan Board in 1861, witness is not aware that any similar plan was brought before Parliament in 1852, *Napier* 398–400——A Bill for the reclamation of land on the Essex coast was obtained some years ago, but this did not involve any application of the sewage, *Hemans* 401, 402.

In 1852 there was an Act for reclaiming the sands, which was also opposed by Mr. Finch, *Hopkins* 948, 949——Circumstance of nothing having yet been done under the Reclamation Act of 1852, *ib.* 1015, 1016. 1065, 1066——Stringent clauses introduced into the Bill of 1852 at the instance of the Admiralty; effect of similar restrictions upon the present scheme, *ib.* 1019–1027.

18. *Reports of Mr. Hopkins and Mr. Hemans respectively:*

A report adverse to the scheme of Mr. Napier and witness was sent in to the Metropolitan Board by Mr. Hopkins, *Hope* 404——The report of Mr. Hopkins was printed by the Board, and witness made a reply to it; there was also a counter-reply by Mr. Hopkins, *Hemans* 407. 410–415.

Witness reported on the scheme on 5th February 1862, and his report was laid before the Metropolitan Board, *Hopkins* 942–945——Subsequently to the withdrawal of the scheme

METROPOLIS SEWAGE AND ESSEX RECLAMATION COMPANY—continued.

18. *Reports of Mr. Hopkins and Mr. Hemans respectively*—continued.

scheme, a reply by Mr. Hemans to witness was laid before the Board and printed, to which witness made a counter reply, but they did not print the latter, *Hopkins* 950–959.

Report by Mr. Hopkins, dated 5th February 1862, at the instance of Mr. Finch, setting forth in detail his grounds for objecting to the plans proposed, with reference more especially to the engineering difficulties of the works, *App.* 431–433.

Letter from Mr. Hemans to the Metropolitan Board, dated 13th February 1862, commenting upon the report of Mr. Hopkins, and denying the soundness of the conclusions arrived at therein, *App.* 433, 434.

Observations by Mr. Hopkins in reply to the letter of Mr. Hemans of 13th February 1862: further explanations therein of his grounds for objecting to the proposed reclamation scheme, *App.* 435–439.

19. *Objections on the part of Mr. Finch in respect of Foulness Island:*

Witness was employed by Mr. Finch to investigate and report upon the scheme, as affecting his property in Foulness Island: data for concluding that good grounds existed for the objections made by Mr. Finch against the scheme, *Hopkins* 929, *et seq.*

Statement by Mr. Finch, owner of the greater part of Foulness Island, submitted to the Metropolitan Board in January 1862, in opposition to the proposed scheme: nuisance and injury apprehended by him, *App.* 430.

Objections raised against the scheme in report by Mr. Hopkins at the instance of Mr. Finch, *App.* 431–433.

20. *Objections by Mr. Shepherd:*

Objections raised against the scheme of Messrs. Napier & Hope by Mr. Shepherd in letter to the Metropolitan Board, in January 1862, *App.* 351, 352.

21. *Objection by the Westminster Board of Works:*

Resolution adverse to the scheme, adopted at a meeting of the Board of Works for the Westminster District, *App.* 446.

22. *Favourable Opinion entertained of the Scheme by the Metropolitan Board:*

More detailed and complete character of this plan than of any other then before the Board, *Thwaites* 85. 96——Reasons of the Board for assuming that this plan would more effectually prevent any nuisance within the Metropolitan Area than any other plan would up to January 1862, *ib.* 87–95. 150.

Evidence to the effect that the embankment walls and works at the Sands may be carried out in the manner, and at the cost, proposed by the promoters, *Bazalgette* 119, *et seq.* 275–286——Data upon which it was concluded by the Metropolitan Board, or Main Drainage Committee, that the scheme in question offered better prospect of profit to the rate-payers than any other plan up to that time submitted, *Thwaites* 150–160.

Examination as to witness not having specially visited the Maplin Sands, and made personal experiments with reference to the reclamation scheme, instead of relying generally upon the figures and data submitted by Mr. Hemans the engineer for the scheme, *Bazalgette* 161–170, 364–376.

Adoption of the scheme by the Main Drainage Committee of the Board, on 10th January 1862, *Hope* 408——Cause of the adjournment by the General Board of the discussion of the scheme, *ib.* 409——Copy of the resolution of the Main Drainage Committee in favour of the scheme, *ib.* 694——Postponement of the decision of the Board further adverted to, *ib.* 699. 700. 707——Circumstance of the scheme having been the only one of so tangible a character as to have been approved by the Board of Works, *ib.* 882–887.

Report by Mr. Bazalgette dated 31st December 1861, with reference to the scheme, and stating that it deserves the favourable consideration of the Board, *App.* 440——Statement by the solicitor of the Board as to the effect of the clauses of the proposed Bill for carrying out the reclamation scheme, *ib.* 440, 441.

Conclusion of the Board, in committee, favourable to the scheme as compared with the other schemes submitted: report on the subject dated 1st January 1862, *App.* 443–444.

23. *Circumstances under which the Scheme eventually dropped:*

The scheme eventually dropped for want of a concession of the sewage, the money deposit not having been made, *Hemans* 411, 412. 448——Recent attendance of Mr. Napier and witness before the Board; position in which the scheme now stands adverted to hereon, *Hope* 707–724.

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23. *Circumstances under which the Scheme eventually dropped*—continued.

At this period of witness's report in February 1862, the concession was in abeyance, and has not since been granted, *Hopkins* 946. 947——Withdrawal of the application for the concession of the sewage in February 1862, the deposit money not having been paid, *ib.* 950. 1085–1087——Probability of the idea of reclamation being abandoned in the face of the difficulties and cost to be encountered, *ib.* 1009.

Statement as to the scheme of Messrs. Napier & Hope having come to nothing because of their inability to procure the required Parliamentary deposit for their Bill, and because of the appointment of a Select Committee to inquire into the whole subject, *Ellis* 1959, 1960——Authority for the statement as to Messrs. Napier & Hope having vainly endeavoured to raise the deposit money for their plan, *ib.* 2496, 2497.

See also *Crouch River.* *Malahide Bay Sands.* *Morecambe Bay Sands.* *Swilly and Foyle Loughs.*

Metropolitan Area. Outline of the limits or boundaries of the Metropolitan Area; the total Area is 117 square miles, *Thwaites* 388, 389——A preference would be given to plans proposing to apply the London sewage outside the Area; that is, with reference to the contingency of a nuisance arising, *ib.* 390, 391.

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The tenders for the utilisation of the sewage of the metropolis have been considered by witness and Mr. Bazalgette, *Thwaites,* 4, 5——The Metropolitan Board first advertised for tenders in January 1846, and again advertised in March and May 1863, *ib.* 7–9——With regard to certain conditions required by the Board on the part of those tendering, witness explains the object of these conditions, and does not consider that they are too costly or too stringent, or that they would act as any undue hindrance to tenders being submitted, *ib.* 10–28.

Witness reported only upon one of the tenders under consideration, *Bazalgette* 38–41——Explanation as to Mr. Bazalgette not having been instructed to report upon any tender or plan save that of Messrs. Napier & Hope, *Thwaites* 76–86——Question as to the deterrent effect of some of the conditions in the advertisement for tenders, further adverted to, *ib.* 341–348.

Rule of the Metropolitan Board generally to accept the lowest tender, *Roche* 5614; *Nicholay* 5730——Practice as to the attendance of the Chairman of the Board at committees, *Roche* 5707. 5710——Attendance of the engineer whenever there is engineering business before the committee, *ib.* 5711——Open and fair way in which discussions take place at the Board, *Nicholay* 5772, 5773——Multifarious work added to the Board since its first constitution, including the duty of carrying out the embankment, *ib.* 5793. 5796–5799.

Suggestions on the part of the Metropolitan Board of Works, in letter to Lord Palmerston in May 1864, for the legislative prohibition of the discharge of sewage into the Thames by any town or village above London, *App.* 261, 262.

Copy of advertisements calling for tenders, showing the conditions required by the Board in connexion with each tender, *App.* 291, 292.

Report of committee of the whole Board on the Main Drainage of the Metropolis, dated 1st January 1862, relative to the several tenders submitted for dealing with the sewage, *App.* 443, 444——Further report of committee of the whole Board, dated 29th July 1863, with reference to the tenders before the Board for utilizing the sewage, *ib.* 444–446.

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Statement of the sums raised by the Metropolitan Board of Works from the several parishes, districts, or parts for the years 1856 to 1864 inclusive, distinguishing the amounts raised for ordinary expenses, and for main drainage, *App.* 492, 493.

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tion, the amount paid on the contract, &c., *App.* 489, 490——Particulars as to the provision made for extra works, in addition to materials or "provisional quantities," *ib.* 494–496.

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Miles, Mr. The results obtained by Mr. Miles, of King's Weston, near Bristol, show that a moderate use of sewage gives very profitable returns, *Ellis* 1813——Reliance placed upon the evidence of Mr. Miles as to the value of a limited application, *ib.* 2463——Very successful results obtained by Mr. Miles from applying the sewage of thirty persons over fourteen acres at King's Weston, *ib.* 2549.

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Moore, John James. (Analysis of his Evidence.)—Has submitted three or four proposals to the Metropolitan Board of Works for dealing with the sewage, 1095–1100——Is engaged principally in agricultural engineering, 1096. 1133—– Details of the plan of distribution, and of the expense, were not furnished to the Board, on account of the costly surveys that would have been necessary, 1101, 1102——Terms offered to the Board by witness's plan in 1860; capital then contemplated, 1103, 1104.

Engagement between witness and the occupiers of 20,000 acres of land in Essex whereby the latter undertook to take the sewage on certain terms; this referred to his plan of 1862; 1105, 1106. 1110, 1111. 1155–1172——Witness did not limit his plan to an area of 20,000 acres, but would apply it to a more extended area, according to the mode of cultivation, 1106. 1110–1116——Proposition in 1862 that if the Board would pump the sewage to a height of 200 feet, witness would ensure them a farthing a ton, which would leave them a profit of 136,000 *l.* a year, 1107–1132. 1145.

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Moore, Mr. Communication to the Metropolitan Board of Works by Mr. J. J. Moore in August 1858 as to the best mode of arranging the drainage of the metropolis in order to supply the sewage, as manure, to agricultural purpose, *App.* 315–317——Correspondence between Mr. Moore and the Board of Works on the subject; details submitted by Mr. Moore in support of his scheme, *ib.* 317 *et seq.*

Letters from Mr. Moore to the Metropolitan Board in August 1859 and January 1860 in further support of his plan for utilizing the sewage in a liquid state, *App.* 324, 325——Tender submitted by Mr. Moore to the Board on 5th July 1860, offering to take all the sewage of the metropolis from the works of the Board on certain terms, *ib.* 327——Letter from Mr. Moore to the Board, dated 10th July 1860, in explanation and support of the terms offered in his tender for the sewage, *ib.* 327, 328.

Communication from the Board of Works to Mr. Moore, dated 16th November 1861, requesting that a map and sections be supplied, together with details as to the working of the scheme, the process of deodorisation, &c., *App.* 328——Letter in reply from Mr. Moore promising to supply the required map and other information at an early date, *ib.* 328, 329——Statement by Mr. Moore, dated 6th February 1862, in explanation of the quality, elevation, &c. of the land to which it is proposed to apply the sewage, *ib.* 329.

Adjournment by the Board of any further consideration of Mr. Moore's scheme, that is, in February 1862, in consequence of the pending appointment of a Select Committee on the subject, *App.* 329.

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Morecambe Bay Sands. Illustration in the case of the Morecambe Bay Sands of the perfect feasibility of the scheme proposed by Messrs. Napier & Hope, for utilising the metropolitan sewage on the Maplin Sands, *Hemans* 500, 501. 506. 631. 775, 776—— Absence of injury to the Morecambe Bay Works since their construction, *ib.* 775, 779.

Absence of analogy between the Morecambe Sands and the Maplin Sands; much more protected position of the former, *Hopkins* 985–987.

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NORTHERN OUTFALL RESERVOIR:

1. *As to the Contract having been obtained by Mr. Furness.*
2. *Question as to the Depth and Size of the Reservoir.*
3. *Amount of Work still to be done before final Completion.*
4. *Penalty for delay in Completion; non-enforcement thereof.*
5. *Question as to the Construction of a Coffer-dam.*
6. *Provision for Covering and Ventilating the Reservoir.*
7. *Contract Price, and Amount paid on Account.*
8. *Provision for Extra Works.*

1. *As to the Contract having been obtained by Mr. Furness:*

Circumstance of Mr. George Furness having obtained the contract for the reservoir on the north side, although there were two or three lower tenders; reasons for the non-acceptance of the latter, *Bazalgette* 5237–5242——Witness tendered for the outfall reservoir on the north side, in which case Mr. Furness got the contract, though there was a lower tender, *Ridley* 5407–5412——Withdrawal by Mr. Docwra of his tender for the Northern Outfall Reservoir, *Thwaites* 5863——Cause of the non-acceptance of the tender of Messrs. Eckersley and Baylis for this reservoir, though 33,000 *l.* less than that of Mr. Furness, *ib.* 5864–5866.

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3. *Amount of Work still to be done before final Completion:*

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5. *Question as to the Construction of a Coffer-dam*—continued.

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RIVERS AND STREAMS (POLLUTION BY SEWAGE, &c.):

1. *Wide-spread Pollution of Streams and Rivers, and Injurious Results therefrom.*
2. *Consideration as to the Preventive Measures desirable to be Adopted.*

1. *Wide-spread Pollution of Streams and Rivers, and Injurious Results therefrom:*

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1. *Wide-spread Pollution of Streams and Rivers, &c.*—continued.

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Unlawfulness of any pollution of rivers if it be a public nuisance or a private damage; several actions at law adverted to in support of this conclusion, *Gael* 3100–3135. 3160–3175, 3252–3255——Several instances of injunctions having been obtained with regard to the pollution of streams by sewage discharge, *ib,* 3160–3175.——Want of some recognised authority for putting the law in motion against the pollution of streams or rivers, *ib.* 3176–3179. 3191. 3208. 3227, 3228.

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Necessity of stringent and extensive powers for preventing the pollution of streams or rivers, the existing penalties being insufficient or inoperative, *Taylor* 3833–3835——Absence at present of any authority specifically appointed for enforcing the law against the pollution of streams, *ib.* 3853–3856. 3926–3934——Considerable difficulty and expense involved in legal proceedings and injunctions, *ib.* 3888–3892. 3896.

Witness is not aware of any law by which the pollution of streams can be prevented, *Rawlinson* 4070, 4071——Grounds for objecting to a prohibition of the use of the streams or rivers as outfalls for sewage; apprehended falling back upon the cesspool system, *ib.* 4098. 4101——Want of check upon the practice of discharging waste matter into the rivers, whereby the bed is gradually filled up, *ib.* 4189, 4190.

Rivers and Streams (Pollution by Sewage, &c.)—continued.

2. *Considerations as to the Preventive Measures, &c.*—continued.

Even if a pecuniary benefit cannot be secured, such steps should be taked by local authorities as are possible to free rivers from pollution, *Rep.* v——Statement as to the Commissioners of Sewers and the Board of Health not having taken steps to prevent the practice of flushing the refuse of houses into the sewers, and thence into the rivers, *ib.* vi.

Recommendation that the object of completely freeing the entire basins of rivers from pollution should be rendered possible by general legislative enactment, enabling the inhabitants of such entire districts to adopt some controlling power for that purpose, *Rep.* vii—— Suggestion, also, that the general enactment should include a provision for compelling Local Boards to render the sewage of their districts innocuous by application to the land for agricultural purposes, *ib.*

See also *Cesspools. Filtration. Fish. Gas Refuse. Health. Keighley (York). Lime Process. Local Boards. Oxford. Penalties (Pollution of Streams). Salmon Fisheries. Thames, The. Water-closets. Watershed Boards.*

Roberts, Charles Henry Crompton, James Brunlees, and George Herbert Townsend. (Analysis of their Evidence.)—(*Mr. Townsend.*) Is secretary to the London Sewage Utilisation Company, 1183——The Company made a tender to the Metropolitan Board for the sewage in 1860, and again in 1863, the plans not having undergone any modification, 1184–1187——The Board had nearly concluded arrangements with the Company, 1186.

(*Mr. Roberts.*) Proposal of the Company to start with an experimental capital of 30,000 *l.*, in order to demonstrate the value of the sewage, 1190, 1191——Estimate of 500,000 *l.* as an ample capital, with a view to the utilisation of the whole of the sewage on the north side, including the works for placing the sewage on the land, 1192–1202. 1216–1219——Contemplated purchase or lease of 9,000 acres of land near the outfall at Barking, to which to apply the sewage, 1193–1196. 1203, 1204. 1240. 1251–1254——Calculations as to the cost or rent of the land, the value to be derived from the sewaged crops, and the profits eventually to be returned, 1205–1214. 1221. 1236–1239.

Proposal to give a peppercorn rent to the Metropolitan Board for some years, and afterwards such rental as the Board of Trade might determine was fair, 1212–1214——(*Mr. Brunlees*)—The total cost of the whole works is 181,588 *l.*; 1220——Way in which the sewage is proposed to be conveyed and distributed, 1222–1227——Quantity of sewage to be applied, and mode of application; necessity in the first instance of a proper system of drainage, 1229, 1230. 1241–1250. 1255, 1256——Witness made eight miles of embankments at Morecambe Bay, and there has been no difficulty in maintaining them, 1231–1235——(*Mr. Roberts*)—Facility with which the land may be had possession of, and a commencement made in the utilisation of the sewage, 1240. 1257–1259.

Roberts, Mr. Communications from Mr. Roberts to the Metropolitan Board, or the Main Drainage Committee, in 1859 and 1860, in explanation and support of his scheme, as represented by the London Sewage Utilisation Company, *App.* 330–334.

See also *London Sewage Utilisation Company.*

Roche, Charles Mills. (Analysis of his Evidence.)—Is a Member of the Metropolitan Board of Works, and was one of the Committee which dealt with the tenders for the first section of the Embankment and Northern Low Level Sewer, 5613. 5618——Practice of the Board usually to accept the lowest tenders, 5614——Witness hesitates about divulging the circumstances which led to the rejection of Mr. Ridley's tender for the first portion of the Low Level Sewer and Embankment; is, however, prepared to do so as urged by the Chairman of the Committee, 5615–5619.

The tender of Mr. Ridley was, in fact, eventally rejected, because of a report by Mr. Bazalgette, that he was not competent to carry out the contract, 5619–5621. 5639–5641. 5655–5660. 5668, 5669——Witness made careful inquiry as to the capabilities of Mr. Ridley, and felt satisfied that he was competent to carry out the contract, 5622——Offer by Mr. Ridley to deposit the whole amount of the security required by the Board, whilst he was aided by the experience of Mr. M'Cormick as to the execution of the works, 5623–5629.

Reference to the Report by a Committee of the Board, disapproving of the conduct of Mr. Bazalgette in the Odessa affair; this was subsequent to the acceptance of the tender of Mr. Furness for the embankment, &c., or the tender would never have been accepted, 5630. 5645—— Witness was guided by the engineer's report in regard to his vote upon Mr. Ridley's tenders, 5641. 5655——Genuine character of the investigation by the Board into the part taken by Mr. Bazalgette in the matter of the Odessa contract, 5646——Testimony borne by Mr. Bazalgette to the past experience of Mr. Furness as a contractor, although he reported very positively against Mr. Ridley; opinion as to the inaccuracy of each of these views, 5647–5656.

Probability of deviation from the original line having been allowed under the contract of Mr. Webster, 5661——Reference to the use by Mr. Forrest of rubbish from the land instead

Roche, Charles Mills. (Analysis of his Evidence)—*continued.*

instead of Thames dredgings, in the formation of the embankment works; doubt as to any report by the engineer on this point, 5662, 5663, 5670, 5671. 5682–5692——Statement as to the tender of Messrs. Baker & Son not having been accepted because it involved an arbitration clause, 5672. 5674——Grounds for disapproving of the system of the Board not to allow the Arbitration Clause in their contracts; effect of this exclusion in limiting competition and in causing more expensive contracts, 5672–5674. 5678–5681. 5693–5698. 5705. 5712–5715.

Explanation as to the Board having decided not to re-advertise for fresh tenders after the rejection of the tenders of Mr. Ridley and Messrs. Baker & Sons; dissent from this determination, 5675–5677. 5699–5701. 5706. 5721–5724——Impression as to the Thames Conservancy having complained of the material being used in filling up the Thames embankment, 5687–5691.

Division at the Metropolitan Board on the subject of the Arbitration Clause; small majority in favour of its exclusion, 5702–5704. 5716–5720——Practice as to the attendance of the Chairman of the Board at Committees, 5707. 5710——Attendance of the engineer whenever there is engineering business before the Committee, 5711——Altered practice in regard to the reading of the engineer's estimates, they not being now made known until the tenders are opened, 5726.

Witness considers that the ultimate rejection of Mr. Ridley's tender has been detrimental to the interests of the ratepayers, and has always thought that he was very hardly treated by the Board, 5727, 5728.

Rotherhithe Vestry. Memorial of the vestry to the Metropolitan Board, submitting that the greatest results are obtaining from the sewage by its moderate application over an extended area of land, *App.* 447.

RUGBY:

1. *Exceptions taken to the Experiments as carried out by Mr. Lawes.*
2. *Explanations on the part of Mr. Lawes and of the Sewage Commission.*
3. *Mode of Sewage Applications by Mr. Walker, and Results obtained.*
4. *Character and Value of the Rugby Sewage.*

1. *Exceptions taken to the Experiments as carried out by Mr. Lawes:*

Slight value attached to the experiments of Mr. Lawes at Rugby conducted on account of the Sewage Commission, *Hope,* 787, 788. 874——Conclusions as to the unsuccessful character of the experiments of Mr. Lawes at Rugby, where very large quantities were applied, *Ellis* 2051, 2052.

Information relative to the experiments carried on by Mr. Lawes on some land of witness's at Rugby; conclusion that the published results prove nothing as to the actual value of the sewage, and tend only to mislead, *Walker* 3625–3638. 3653, 3654. 3675–3686. 3712, 3713. 3727——Very defective manner in which the sewage was applied; large waste at times, *ib.* 3627–3635——The ground was drowned at one time and parched at another time, *ib.* 3628, 3629.

Destruction of all the finer grasses and deterioration of the value of the land in consequence of the defective manner in which the sewage was applied, and the crops cut, *Walker* 3628–3633. 3639. 3708. 3722–3726. 3731——Larger returns if there had been smaller dressings of sewage applied, *ib,* 3635, 3636. 3653–3670. 3675. 3683–3693——Recent admission by Mr. Lawes that the management of the lands agriculturally had not been satisfactory, *ib.* 3730.

Witness is a tenant farmer near Rugby, and is well conversant with the sewage experiments of Mr. Walker and Mr. Lawes, *Congreve* 5007–5013. 5050–5052——Considers that though larger grass crops were produced at Rugby by Mr. Lawes, the crops are much worse in quality, and the lands greatly injured, *ib.* 5014 *et seq.* 5068–5091——Improved state of the land when Mr. Lawes began his experiments, so that the crops are not due entirely to the sewage, *ib.* 5027.

Inferior character of the land since the sewage applications, as compared with unsewaged land, *Congreve* 5028–5030. 5045. 5054–5070——Explanation of the circumstances under which witness gave up the land formerly held by him, and subjected to the sewage experiments, *ib.* 5094–5104

2. *Explanations on the part of Mr. Lawes and of the Sewage Commission:*

Neither witness nor any of his staff received remuneration from Government for carrying out the sewage experiments at Rugby, *Lawes,* 4303–4306——The public expense was limited to the rent of the land, the sewage, and the labour, *ib.* 4307. 4503, 4504.

Explanation and defence of the manner in which the sewage was applied at Rugby, *Lawes* 4308 *et seq.*——Dissent from the conclusions of Lord Essex that the Rugby experiments were not carried out in a manner to prove the full value of sewage, *ib.* 4309–4313. 4336, 4337——Denial that the experiments are delusive and apt to mislead the public, as stated by Mr. Walker, the owner of the land, *ib.* 4314–4325. 4414–4421.

RUGBY—continued.

2. *Explanations on the part of Mr. Lawes, &c.*—continued.

Application of the sewage in stated quantities at different times, whether there was a rainfall or not, *Lawes* 4316-4318——Information as to the cutting of the grass at Rugby, and the effect of the sewage upon the finer grasses, *ib.* 4320-4323. 4422——Denial that Mr. Walker's land was permanently and greatly injured by the experiments, *ib.* 4326.

Circumstance of witness not having applied a less quantity than 3,000 tons per acre; belief that 600 tons would not have produced anything like the same result, *Lawes* 4352. 4359, 4360. 4423-4427——Numerous dressings in which the sewage was applied, *ib.* 4353-4358.

Further statement in justification generally of the conduct of the Rugby experiments by witness, *Lawes* 4404-4430——Statement showing that the soil at Rugby is not the best adapted soil for sewage application, *ib.* 4484-4492——Explanation as to the Rugby sewage having been applied every month in certain regulated quantities, *ib.* 4498-4502——Reasons for applying the Rugby sewage in a large quantity over a small area, *ib.* 4502. 4512, 4513.

Witness, though one of the Sewage Commission, explains that he is not prepared to give evidence relative to the experiments at Rugby; he states, however, that the sewage was applied in a very costly manner, *Rawlinson* 4134-4141. 4235——Selection of Mr. Lawes to carry out the experiments of the Commission on account of his large agricultural experience and the staff at his disposal, *Way* 4791.

3. *Mode of Sewage Applications by Mr. Walker, and Results obtained:*

Witness took a lease of the sewage of Rugby in 1853, with a view to preserve the river from pollution, and to fertilise his own land, *Walker* 3603-3606——Erection of a tank and steam engine, with pipes and open gutters for purposes of distribution, *ib.* 3607-3610. 3694-3696——Successful result from the application of the sewage, especially in the case of green crops and grass land, *ib.* 3613-3616. 3640-4643. 3654-3670——Inoffensiveness of the sewage as applied on witness's land, *ib.* 3621.

Payment by witness of a rent of 50 *l.* a year for the sewage of Rugby; it probably pays him to give this rent, but the other expenses and trouble are great, and he ought to receive the sewage for nothing, *Walker* 3644-3649. 3652. 3671, 3672. 3694. 3715-3718 3732-3738——Witness's working expenses were 250 *l.* an acre, *ib.* 3652——The works deliver nearly 200,000 gallons a day, there being twelve-horse power, *ib.* 3652. 3695, 3696——Witness does not now occupy the land, but understands that his tenant cuts the grass only once, and then turns cattle in, *ib.* 3654-3669. 3709-3711——Character of the soil of witness's land and of the drainage, *ib.* 3702-3704.

Unnecessary outlay by Mr. Walker of Rugby in pipeage, so that the result in his case might have been more favourable, *Rawlinson* 4139, 4140, 4233, 1234. 4237-4239.

4. *Character and Value of the Rugby Sewage:*

Particulars relative to the manurial elements of the Rugby sewage, of which very careful analyses have been taken, *Lawes* 4431-4439——Grounds for concluding that the Rugby sewage is less diluted and more valuable than the London sewage, *ib.* 4432, 4433. 4450, 4451——Calculation that the fertilising ingredients of the Rugby sewage are worth only ½ *d.* per ton, *ib.* 4440-4446——Richer character of the Rugby sewage than the London sewage; quantity of ammonia in the former, *Way* 4848-4850. 4892-4894. 4990, 4991——Amount of the water supply at Rugby and of the population; varying character of the sewage, *Congreve* 5031-5042.

See also *Campbell, Mr.*

S.

St. Olave's, Southwark. Memorial of the Board of Works for the district of St. Olave, to the Metropolitan Board of Works, with reference to a revenue being derived from the sewage, *App.* 447, 448.

St. Saviour's, Southwark. Memorial of the district Board of Works as to the importance of dealing with the metropolitan sewage for general agricultural purposes, *App*, 446, 447.

Salford. Reference to the abandonment of a large proposed expenditure by Salford for freeing the river from sewage, because other adjacent towns would not join in the movement, *Taylor* 3841, 3842——Refusal of other towns to co-operate with Salford in measures for excluding sewage from the Irwell, *Rawlinson* 4013-4015.

Salmon Fisheries. Uselessness of attempting to breed salmon in the Thames so long as the sewage of London flows into it; very valuable salmon fisheries in the river if purified, *Fennell* 2926-2934——The salmon fisheries generally are to a great extent the property of the public and should be protected at the public expense, *ib.* 2997-3007.

Sandy Soils. Grounds for concluding that the sands, as on the Essex coast, would be fertilised by the action of the sewage, and that the growing crops would absorb the fertilising property of the sewage in solution, *Hope* 526–536. 890–898. 900–902. 910–920——Large present value of the Craigentinny Meadows near Edinburgh, though composed of sand from the sea-shore, *ib.* 536. 590. 626——Greater loss of manurial properties of the sewage in sandy soils than in good soils, *Ellis* 2048–2050. 2051. 2131.

A sandy soil is the best purifier of sewage water, *Lawes* 4475–4479. 4491, 4492. 4496, 4497——Sandy land reclaimed from the sea would be the best land to which to apply the sewage, *ib.* 4540–4543. 4672——Sandy soil though absorbing a larger amount of sewage water than clay soil absorbs, does not equally retain the fertilising ingredients, *ib.* 4640–4646.

Advantages in applying the London sewage to a sandy soil, *Way* 4914–4936——Belief that sandy soil would become a light friable loam by the deposit of the suspended matters in the sewage, *ib.* 4920, 4921. 4929–4933, 4936.

See also *Bagshot Heath. Metropolis Sewage and Essex Reclamation Company.*

Sanitary Commission. Reports of the Sanitary Commissioners adverted to as showing that they contemplated the application of the cesspool matter to the land as a fertilizer, *Gael* 3144, 3145.

Sewage Commission. The Commission has made two reports and is about to make a third, *Lawes* 4301, 4302. *See* also *Rugby* 1, 2.

Sewers. Witness prepared charts of all the Sewer Acts and Paving Acts in London, in connection with the Survey Consolidation Act of 1848, *Gael* 3010–3012——Supplies sundry particulars relative to the first constitution and objects of Commissioners of Sewers in the Metropolis, and the extensions and alterations effected from time to time by subsequent Acts, *ib.* 3013 *et seq.*——Application originally of the word "sewer" to waterways which were navigable, the Act of James the First first extending the term to gutters, streams, and watercourses, *ib.* 3015–3028——Extension also of the jurisdiction of the Commissioners of Sewers by the several Private Acts relating to the different Commissions, *ib.* 3029–3041.

Mention of several Acts authorising Commissioners of Sewers to make new sewers, *Gael* 3033–3038——Statement as to sewerage having formerly been a landlord's tax, according as the necessity arose, *ib.* 3035. 3039–3041——Three different classifications of sewers, including house drains; jurisdiction of the Commissioners over the latter since 1847, *ib.* 3042, 3043——Reference to the public sewers or open watercourses as forming a distinct class, such as the Fleet Ditch; covering of these adverted to, *ib.* 3044–3049.

Information relative to the class of common or street sewers as made by the Commissioners of Sewers, or by the Paving Commissioners; restriction upon any private or house drains being opened into these, *Gael* 3050–3076——Details relative to the former cesspool system; restrictions still existing under the common law in regard to the emptying of these into the sewers, *ib.* 3062 *et seq.*

Paper delivered in by Mr. Gael, being a sewer chart prepared by him with reference to the Metropolitan sewers in former years, their management, &c., *App.* 278, 279.

See also *Cesspools. Main Drainage Works. Rivers and Streams. Water-closets.*

Shepherd, George. (Analysis of his Evidence.)—Is Engineer of the London and Provincial Sewage Company: has tendered for the London sewage in order to utilise it in a liquid state, 1606–1610——Considers that the sewage may, with a good profit, be delivered on farms to a distance of 100 miles round London at one-fourth the cost of guano, 1611–1616——Proposes that all surplus profits above 7½ per cent. be shared in by the Metropolitan Board, 1615. 1700.

Discovery by witness that the solid matter taken from the sewage is valueless, 1617——Calculation that the liquid sewage is worth throughout the year an average of 1 ¼*d.* per ton to the farmers, 1618–1620——Particulars as to the reservoirs, mains, and other works for the distribution of the sewage upon witness's plan, 1621–1651——The plan of Mr. Ellis is taken from that of witness, 1630——Consideration of the cost of the works in detail; enormous aggregate if a radius of 100 miles round London be dealt with in its entirety, which, however, witness never contemplated, 1641 *et seq.*——Further statement that the sewage can be delivered at a quarter the price of guano, or ½*d.* per ton, 1691–1697.

Explanation relative to the failure of the Croydon Sewage Irrigation Company, to which witness was engineer, 1701–1707——Statement as to witness having designated himself an engineer to the "London, Midland Counties, and General Sewage Irrigation Company," which is just formed, 1708–1715——Works about to be commenced by witness at Coventry, where he states that he has got a conditional concession of the sewage; reference hereon to a recent communication from the town clerk of Coventry to the Chairman of the Committee, in which it is denied that there is now any negotiation open with witness, 1716–1725.

Shepherd, Mr. Sundry communications from Mr. Shepherd to the Metropolitan Board in explanation and support of his scheme for utilising the sewage by application to agricultural purposes, and asking for a concession of the sewage on certain terms, *App.* 339 *et seq.*

Letter from Mr. Shepherd to the Metropolitan Board of Works, dated 15th February 1864, relative to the value of the sewage, and the price at which it may be sold to the farmers, *App.* 458.

Sherborne (*Dorset*). Very imperfect attempt made to intercept and utilise the sewage of Sherborne, *Whitehead* 2705–2710——Pollution caused by the sewage of Sherborne, the river into which it flows being unfit for the use of cattle, and not containing any fish, *ib.* 2798–2810.

Small Parishes. Authorities responsible in small parishes for the removal of nuisances; much less sanitary work done in such places than should be done, *Taylor* 3977–3983.

Smith, Richard. See *Fox, Sir Charles, &c.*

Solid Manure (*Sewage*). Nature of the terms offered by Mr. Kirkman in conjunction with the plan for deodorising and utilising the sewage by solidifying it; doubt whether this plan could be carried out with profit, *Thwaites* 55–61——Opinion as to there being less prospect of profit by solidifying sewage than by applying it in a liquid state, *ib.* 58–60. 222, 223——Failure of the experiments at Leicester for extracting a solid manure from the sewage, *Smith* 1559; *Taylor* 3914–3916; *Rawlinson* 4031–4034; *Way* 4901–4903——The solid matter taken from the sewage is valueless, *Shepherd* 1617.

Statement as to the sewage being of much greater value as a manure when applied in a liquid than in a solid state, *Ellis* 1797–1801. 1804. 2415, 2416——Impracticability of extracting from the sewage all the manurial property, and drying it; so that its value in a solid state is quite theoretical, *ib.* 2412–2414——Reference to a statement by Professor Way as to the importance of extracting and drying the fertilising substance in the sewage, *ib.* 2419–2421——Disapproval of any system for solidifying town sewage, *Walker* 3720, 3721.

Obstacle to getting rid of the evil by converting the solid portion of the sewage into manure, *Taylor* 3894, 3895——Reference to the failure of all attempts hitherto to deodorise sewage, and make a portable manure to rival guano, *Rawlinson* 4231, 4232.

Impracticability of producing, at a profit, dry manure from sewage, *Way* 4749, 4750——The solid manure made at Leicester is now selling at 2*s.* a ton, *ib.* 4903.

Communication from Dr. Thudichum, together with memorandum and sundry tables, explanatory of his plan for converting the urine of the metropolis into a solid manure, *App.* 298–314.

Papers explanatory of the scheme of Mr. Kirkman for dealing with the sewage as a solid manure, *App.* 354–361——Further particulars submitted by Mr. Kirkman in March and April 1864, as to the terms on which he is prepared to take the sewage, *ib.* 460, 461.

See also *Chelmsford. Kirkman, C. F. Nelson, James Edward. Thudichum, Dr. Tottenham. Value of Sewage.*

Sombrero Guano. About 15,000 tons of Sombrero guano are used in this country, chiefly for making superphosphate as a manure; the price of the former is about 6*l.* per ton, *Way,* 4781–4784.

Southern High Level Sewer. Instance of deduction in regard to extra works, in the case of the contract for the Southern High Level Sewer, *Thwaites* 5880–5888.

Statement of the names of persons from whom tenders were received for this work, of the amounts, and of the sureties, *App.* 481——Also of the successful tender, and its amount, *ib.* 486——Returns showing the time when the contract was entered into, when the works were to have been completed, and when they were actually printed and delivered to the Board; also the amount actually paid on the contract, &c., *ib.* 489, 490——Paper dated 28th June 1864, containing particulars relative to the provisions made for extra works, and the amounts paid on that score, *ib.* 494, 495.

Southern Low Level Sewer. Evidence relative to the deviation allowed from the contract line in the case of the Low Level Sewer on the south side; question as to any deduction from the estimates in consequence, *Ridley* 5495–5501——Witness tendered for the South Low Level Sewer, but declined to undertake the contract on account of the conditions relative to the assessment, *ib.* 5548, 5549——Probability of deviations from the original line having been allowed under the contract of Mr. Webster, *Roche* 5661.

Reference to the withdrawal by Mr. Ridley of his tender for the Southern Low Level Sewer, *Thwaites* 5861, 5862.

List of the names of the contractors who tendered for the work, and of the amounts of their several tenders, with the names of the sureties proposed, *App.* 483——Further statement showing the tender accepted, the amount thereof, and the names of the sureties accepted, *Southern Low Level Sewer*—continued.

accepted, *App.* 488——Returns showing the time when the contract was entered into, the time for completion, the amount paid on the contract, &c., *ib.* 489, 490——Particulars as to the provision made for extra works, in addition to materials or " provisional quantities," *ib.* 494–496.

Explanation by Mr. Bazalgette relative to the deviations from the line of sewer laid down in the original drawings, *App.* 498.

Southern Outfall Reservoir. The area of the south side reservoir is 6½ acres, the depth 14¼ feet, and the cubical contents 4,000,000 feet, *Bazalgette* 5140. 5142——The reservoir is covered, due provision being made for ventilation, *ib.* 5141——There was a large additional payment, besides 45,000*l.* for extra works, in the case of the Southern Outfall Sewer, *Thwaites* 5898–5900.

Statement of the names of persons from whom tenders were received, of the amounts, and of the sureties, *App.* 481, 482——Also of the successful tender, and its amount, *ib.* 487——Statement of the time when the contract for the works was entered into, the time for completion, the date when the contract was finished, and the amount paid on account, &c. *ib.* 489, 490——Further particulars relative to the contract, showing the amount paid for extra works, &c. *ib.* 494–496.

Southern Outfall Works (*Crossness*). Cause of the rejection of the tenders of Messrs Myers and Company, and Mr. Ward, for the Southern Outfall Works at Crossness, and the acceptance instead of the higher tender of Mr. Webster, *Thwaites* 5844–5856.

List of the contractors who tendered for the works, and of the amounts of the several tenders, with the names of the sureties proposed, *App.* 483——Further statement showing the tenders accepted, the amount thereof, and the names of the sureties accepted, *ib.* 487——Returns showing the time when the contract was entered into, the time for completion, the amount paid on the contract, &c. *ib.* 489, 490——Particulars as to the provision made for extra works in addition to materials or provisional quantities, *ib.* 494–496.

Starling, W. D., and *Others.* Proposition by Mr. Starling, Mr. Westwood, and others, in letter to the Metropolitan Board, dated 24 September 1863, for dealing with the London sewage on certain terms, *App.* 455, 456.

Storm Overflows. Expediency of facilities for utilising the storm-water sewage, instead of sending it into the Thames, *Hopkins* 1069–1071——Statement in explanation of its being now considered that the storm overflow is as valuable as the ordinary sewage, *Sir C. Fox* 1380——Rare occasions of storm overflows into the Thames; slight pollution of the River thereby, *Mr. Smith* and *Sir C. Fox* 1441–1443. 1472–1474. 1502–1506——Advantage in all storm overflow being dealt with and utilised, *Smith* 1470–1474.

Grounds for concluding that the sewage in wet weather, or the storm sewage, is much richer in manurial properties than the dry weather sewage, *Ellis* 1741, 1742——Impracticability of utilising the floods or wet weather sewage of London or of other towns, *Rawlinson* 4160, 4161——Inaccuracy of the assumption that the sewage is on the whole richer during storm overflows than at other times, *Way* 4713–4720.

Particulars as to the provision made by the main drainage scheme for rainfall and for storm overflows, and the data upon which calculated, *Bazalgette* 5144–5149——There are about twenty-five storm outlets for carrying off the overflow into the river, *ib* 5146, 5147.

See also *Rainfall.*

Streams, Pollution of. See *Rivers and Streams.*

Superphosphate of Lime. There are probably from 150,000 to 200,000 tons of superphosphate of lime sold in this country, the price averaging 7 *l.* per ton, *Way* 4774, 4775——Probable means of obtaining ample supplies of superphosphate of lime, *ib.* 4987–4989.

Surveys. See *Plans and Surveys.*

Swilly and Foyle, Loughs. Very successful reclamation of sands and mud land by embankments at Loughs Swilly and Foyle; inference favourable to the scheme for utilising the London sewage by reclaiming the Maplin Sands, and applying it thereto, *Hemans* 725–735.

T

Tame River. Exceedingly foul state of the River Tame, whence the water supply of Birmingham is partly derived; health of Birmingham adverted to hereon ***Rawlinson*** 4048–4056.

Taunton. Amount of the sewage of Taunton flowing into the River Tone; very polluted state of the river, no remedy having been attempted, ***Whitehead*** 2782–2788.

Taylor, Tom, M.A. (Analysis of his Evidence.)—Is Secretary to the Local Government Board, 3797——Statement of the powers acquired by Local Boards adopting the Local Government Act, 3798——Powers of Local Boards, under the Public Health Act of 1848, for dealing with sewage, 3798–3802——Nature of the extended powers given by the Local Government Act in enlargement of the powers already possessed under the Public Health Act, 3803–3810——Conditions subject to which Local Boards may make sewers and reservoirs beyond their district for the distribution of sewage, 3807–3812.

Practice generally of Local Boards, in dealing with the sewage, to run it into the nearest river or stream, 3813——Increased number of injunctions against Local Boards, in consequence of the pollution of the streams, 3814, 3815. 3852——Several injunctions obtained in the Croydon case, the local authorities being ultimately driven to apply the sewage to the land, 3816. 3821——Informations relative to the injunctions obtained in 1857 against the Uxbridge Local Board in regard to the discharge of sewage into the River Colne, 3822. 3828——Effect of the injunction in the case of Hitchin to cause the whole Local Board to resign, so that there is now no Local Board responsible in the matter of the sewage, 3829. 3832. 3962.

Necessity of stringent and extensive powers for preventing the pollution of streams or rivers, 3833——Heavy penalties under different Acts in regard to the pollution of streams, 3834, 3835——Application of the Local Government Act to single towns and districts, there being no power applicable to whole catchment basins, 3836. 3840——Reference to the abandonment of a large proposed expenditure by Salford for freeing the river from sewage, because other adjacent towns would not join in the movement, 3841, 3842.

Conclusion as to the only alternative, if the sewage be by law excluded from the rivers, being to utilise it upon the land in a liquid form, 3843–3845. 3848. 3968–3975——Statement as to the General Board of Health having always had in view the application of the sewage to land, 3845——Notion entertained by the former Commissioners of Sewers that the refuse from the houses should in time be excluded from the river, and utilised, 3846.

General abandonment of cesspools since the year 1840, the drainage of towns being now greatly improved, and the house refuse being discharged into sewers, 3847–3852——Growing character of the evil of sewage discharge into rivers, so that some further controlling authority is required, 3852–3862——Absence at present of any authority specifically appointed for enforcing the law against the pollution of the streams, 3853–3856.

Disapproval of the Local Government Act being applied to whole watersheds or catchment basins, 3863——Necessity of an Act of Parliament in order to define the functions of Boards for dealing with watersheds, 3864——Proper duty of Watershed Boards to see that local Boards of towns did not pollute the rivers; question hereon as to the expediency of a direct central control over the former Boards, 3865–3877. 3907. 3950–3964——Extent of the powers of Local Boards in regard to acquiring land beyond their districts in connexion with sewage works, 3878–3880. 3903, 3904. 3939, 3940.

Question considered as to the means of restraining Improvement Commissioners, under Private Acts, from polluting streams; doubt as to the expediency of placing such Commissioners, compulsorily, under the Local Government Act, 3881–3885——Advantages of a Local Government Act of general application, in lieu of an Act which may be adopted or applied, 3885–3887——Circumstances under which considerable difficulty and expense are involved in obtaining injunctions against persons for polluting streams, 3888–3892——Effect of the more general use of water-closets in increasing the pollution, 3893.

Obstacle to getting rid of the evil by converting the solid portion of the sewage into manure, 3894, 3895——Practice at Chelmsford of disposing separately of the solid portion of the sewage, 3894——Difficulty in regard to private individuals summoning persons who pollute the streams before the magistrates in petty sessions, 3896——The Local Boards are in one sense the great offenders; that is, as regards the discharge of excrementitious matter into the sewers and the streams, 3897——Absence of penalty upon persons fouling streams by throwing dead animals into them, 3898–3901——Penalties which may be inflicted by summary proceedings in the case of the fouling of streams under the control of Local Boards, 3898–3900. 3902.

Probable usefulness of a power in local Boards to take proceedings against other local Boards responsible for the pollution of the same stream higher up; advantage, however,

Taylor, Tom, M.A. (Analysis of his Evidence)—*continued.*

however, of one general authority over the whole watershed, 3905-3907——Opinion that it would be premature at once to compel local Boards to apply the sewage on land; some successful mode of application should first be ascertained, 3908-3917. 3951, 3952, 3965-3975——Conditions under which corporations, as distinct from local Boards, may exercise extended powers for carrying out sewage utilisation works, 3918-3925.

Further statement in connection with the absence of any authority on the part of the public for enforcing the law relative to the pollution of streams; inexpediency of this duty being devolved upon witness or his Board, 3926-3934——Suggestions as to the constitution and powers of watershed Boards, 3935, 3936. 3952-3964——Necessity of a power of rating in the watershed Boards, 3936. 3954-3956. 3960——Probable clashing of authority in the working of these Boards and of the local Boards of towns, 3937, 3938——Bodies legally responsible for nuisances in places where there is not a local Board, 3941-3943——Doubt whether cesspools can be arranged on an improved and unobjectionable system for utilising the excrements, 3944, 3945.

Absence of any real power in the local Government Office over the acts of the local Boards; opinion as to the inexpediency of such power, 3946-3950——Doubt whether the pollution of streams has as yet gone so far as to be any grave detriment to health; it is, however, a great and growing evil, 3965-3967——Ineffectiveness of filtration works as a means of preventing pollution, 3969-3971——Authorities responsible in small parishes for the removal of nuisances; much less sanitary work is done in such places than should be done, 3977-3983——The catchment basin of any river may be in two or three counties, and is quite irrespective of any existing division, 3984.

Temperature (*Sewage application to Land*). Increased crops from sewage applications in years when the temperature is most warm, *Lawes* 4447-4449. 4453. 4531-4533——Smaller results produced by sewage applications in 1862 than in 1863, on account of the colder temperature in the former years, *ib.* 4657-4639. 4668-4671.

Tenders (*Main Drainage Works, &c.*) Practice of the Metropolitan Board usually to accept the lowest tenders, *Roche* 5614; *Nicholay* 5730——Instance of a largely increased expense through re-advertising for tenders, *Roche* 5701; *Nicholay* 5765; *Thwaites* 5914-5924——Explanation as to the reasons generally of the Board for not re-advertising when the lowest tenders are not accepted, *Thwaites* 5922-5927.

See also *Engines*, 2. *Northern Outfall Reservoir. Thames Embankment, &c.*

TENDERS (*UTILISATION OF SEWAGE*):

The tenders for the utilisation of the sewage of the metropolis have been considered by witness and Mr. Bazalgette, *Thwaites* 4, 5——The Metropolitan Board first advertised for tenders in January 1860, and again advertised in March and May 1863, *ib.* 7-9——With regard to certain conditions required on the part of those tendering, witness explains the object of these conditions, and does not consider that they are too costly or too stringent, or that they would act as any undue hindrance to tenders being submitted, *ib.* 10-28.

Reason for requiring in the tenders a description of the works proposed, of the area on which it was intended to distribute the sewage, and of the principle of distribution; this did not involve any very expensive detail in the tenders, *Thwaites* 10-14——Explanation as to the Board having required that the works should be entirely handed over to them in the event of a failure of the contractors, *ib.* 15-23. 341-348——Statement as to its having been made a condition that the tender must contain the names of two or more sureties, to be responsible for the efficient execution of the works, *ib.* 24-28.

Several persons or companies from whom tenders were received up to 1st January 1862; outline of the proposals involved in each tender, *Thwaites* 29-36, 47 *et seq.*——Conditions under which the several companies or individuals have tendered to utilise the sewage in a liquid state, *ib.* 32 *et seq.*——Witness reported only upon one of the tenders under consideration, *Bazalgette* 38-41——Explanation as to Mr. Bazalgette not having been instructed to report upon any tender or plan save that of Messrs. Napier and Hope, *Thwaites* 76-86.

List of persons who submitted tenders in 1863 in consequence of advertisements in March and May 1863; these tenders were opened about 9th July, *Thwaites* 171-173——Very few of the tenders which contained particulars as to the area to be dealt with, or other details required by the Board, *ib.* 185. 192-206. 245-249——With regard to some communications received by the Board in September and October 1863, relative to the utilisation of the sewage, those were not in the nature of tenders, *ib.* 208-211——None of the plans are very satisfactory to the Board, *ib.* 287——About six or seven of the plans are of a definite character, *ib.* 289——There has been no new plan since the plans published in 1863, *ib.* 290, 291.

Question as to the deterrent effect of some of the conditions in the advertisement for tenders, further adverted to, *Thwaites* 341-348——Statement as to the publication given by the Board to the tenders received, *ib.* 364-369.

TENDERS (*UTILISATION OF SEWAGE*)—continued.

Witness objected to comply with the conditions of the Board's advertisement, as rendering it exeeedingly difficult to obtain the land upon which to apply the sewage, *Sir C. Fox* 1263–1266.

Copy of advertisements calling for tenders, showing the conditions required by the Board in connection with each tender, *App.* 291, 292.

Statement in communications from Mr. Roberts to the Board, in April 1859 and January 1860, requesting that publicity be not given to the scheme of the London Sewage Utilisation Company, *App.* 332–334.

Report dated 1 January 1862, of the Committee of the whole Metropolitan Board, on the main drainage of the metropolis, reviewing the several schemes submitted for applying the sewage to agricultural purposes, *App.* 443, 444——Further report by the Committee of the whole Board, dated 29 July 1863, upon the tenders then before the Board, *ib.* 444–446.

Exception taken by the Lambeth vestry to the form of tender required by the Board as excluding fair and open competition for the contracts, *App.* 447.

Paper showing the proceedings of the Metropolitan Board in advertising for tenders, and in reporting thereupon at different times, *App.* 467–471.

See also *Kirkman, C. F. Liquid Sewage Manure Company. London and Provincial Sewage Company. London and Provincial Towns Sewage Irrigation Company. London Sewage Utilisation Company. M'Clean, John R. Metropolis Sewage and Essex Reclamation Company. Plans and Surveys. Thudichum, Dr. Torrington, Lord, and others.*

THAMES, THE:

1. *Very polluted state of the River from discharges of Sewage, &c. above London.*
2. *Effect as regards the Public Health and Mortality.*
3. *Considerations as to the Measures desirable for preventing Pollution.*

1. *Very polluted state of the River from discharges of Sewage, &c. above London:*

Pollution of the Thames irrespectively of the sewage to be removed by the Main Drainage Scheme, *Bazalgette,* 383, 384——On the score both of pollution and of flooding, the condition of the Thames valley is a national disgrace, *Acland* 3445–3450.

Evidence relative to the disgraceful and injurious state of the river at and about Oxford, *Acland* 3448 *et seq.*——Considerable deposit from town sewage in many parts of the Thames, high up the river; instance at Oxford, *ib.* 3454–3456. 3573.

Circumstance of the Thames receiving the sewage of 800,000 before the London water supply is taken from it, *Rawlinson* 3993. 4040–4047——More injurious and impure state of the Thames water above tide-mark when there is least water in the river, and it is apparently most clear and pure, *ib.* 4199–4203.

2. *Effect as regards the Public Health and Mortality:*

Baneful effect upon the health of persons using water from rivers into which sewage flows, *Whitehead* 2756–2762. 2771–2773. 2811–2814——Injury to health in consequence of the sodden condition of the ground about Oxford, &c. from floodings and overflows from mill works, &c., *Acland* 3450 *et seq.*——Infection of the water and of the air by excrements and refuse discharged into the river, so that epidemics are likely to be propagated, *ib.* 3456, 3457. 3515–3520——Difficulty in proving the actual amount of injury to health through the pollution of, and the overflows from the river; conviction that injury must arise from these causes, *ib.* 3530–3539.

Question as to the effect upon health by using the water from rivers into which sewage is discharged, *Rawlinson* 4016–4020. 4026——Great difficulty in proving that any increase of mortality has arisen from the foul atmosphere engendered by the river, *ib.* 4022–4025. 4122–4127.

3. *Considerations as to the Measures desirable for preventing Pollution:*

Grounds for the proposition that Government should take in hand the regulation of the waters throughout the catchment basin of the Thames, *Ackland* 3462–3467——Reference to a memorial to Sir George Grey in 1862, praying for a Royal Commission to inquire into and report upon the state of the Thames Valley; influential character of this memorial, *ib.* 3462. 3463. 3473. 3560–3563. 3574–3578——Limited injury to private individuals by a proper regulation of the waters in the Thames basin, whereas, on the other hand, great public benefit would accrue, *ib.* 3466, 3467.

Absolute

THAMES, THE—continued.

3. *Considerations as the Measures, &c.*—continued.

Absolute necessity of fresh legislation in order to deal with the Thames-valley as a whole, including the question of sewage protection, *Acland* 3470–3472. 3479-3481——Expediency in the first instance of a proper inquiry and report, *ib.* 3473. 3560——There might be two bodies formed for dealing with the river above and below Teddington Lock respectively, *ib.* 3578, 3579.

Letter from the Chairman of the Board of Works to Lord Palmerston, dated 12 May 1864, submitting the urgent necessity for legislative action in order to prevent the rapidly increasing pollution of the river by the several towns and populous places on its banks above the metropolis, *App.* 261, 262.

Memorial, dated 28 May 1862, submitting the expediency of some systematic plan for protecting from pollution the Thames and its tributaries above London, and soliciting the appointment by Government of a Commission of Inquiry, *App.* 272, 273.

Letter from Mr. Rawlinson to the Chairman of the Committee, representing the necessity of adopting measures for preventing the pollution of the Thames above London, *App.* 274.

Special and immediate attention required in the case of the valley of the Thames, where the purification of the river by means of the main drainage works, is to a great extent counteracted by the increased discharge of sewage from towns higher up the stream, *Rep.* vii.

See also *Filtration.* *Oxford.* *Salmon Fisheries.* *Sewers.* *Water Supply* *Watershed Boards.*

THAMES EMBANKMENT AND NORTHERN LOW LEVEL SEWER:

1. *Details in connection with the Non-acceptance of the Tender of Mr. Ridley (though the lowest) for the First Section of the Embankment and Low Level Sewer.*
2. *Cause of the Non-acceptance of the Tender of Messrs. Baker and Son.*
3. *Considerations as to the Acceptance of the Tender of Mr. Furness, though higher than the two preceding Tenders.*
4. *Particulars relative to the Material being used by Mr. Furness in the Construction of the Work; large profits of the Contractor on this Score.*
5. *Payment to the Contractor on account of Work done.*
6. *Conditions in regard to Extra Works and Provisional Quantities.*
7. *Estimate of the Cost of the Embankment on the North Side.*

1. *Details in connection with the Non-acceptance of the Tender of Mr. Ridley (though the lowest) for the First Section of the Embankment and Low Level Sewer.*

Examination as to the non-acceptance of Mr. Ridley's tender for the first section of the low level sewer, although the lowest tender; unwillingness of witness to divulge the reasons which guided the Board in the matter, *Bazalgette* 5248-5258. 5287–5289——Witness considers it would be a breach of confidence if he divulged the reasons of the Board for not accepting Mr. Ridley's contract, *ib.* 5252-5254——The Board were not satisfied with the inquiries which were made, either as regarded Mr. Ridley or his sureties *ib.* 5255.

Witness employed Mr. Cleaver and Mr. Sewin of Boston to make the calculations on which he based his tender for the first portion of the low level sewer and embankment, *Ridley* 5380——Witness is a measuring surveyor, and made the estimates referred to by Mr. Ridley, *Cleaver* 5381–5383——The tender of witness was the lowest, and there were two others lower than the tender of Mr. Furness, *Ridley* 5384–5390.

Witness was declared the contractor, but an objection was made by the Metropolitan Board to one of his sureties, and to his own practical experience; offer hereon by witness to deposit the full amount of the security, namely 20,000 *l.*, and to send in two more sureties, *Ridley* 5391–5402——Explanation of the circumstances under which Mr. McCormick, having made an error in his own tender, eventually became associated with witness's contract, and brought in his own responsibility and reputation as a security for the efficient performance of the works, *ib.* 5403–5406.

Witness explains the circumstances under which he joined Mr. Ridley in his contract for the first section of the Thames embankment and low level sewer; he has carried out works of much greater magnitude and difficulty, *McCormick* 5440–5443. 5563, 5564. The error in witness's tender was caused by his having estimated for a double coffer dam, which was not at all necessary, *ib.* 5440. 5556–5563.

Witness was asked numerous questions by members of the Board, and had some conversation with the engineer of the Board on the subject of the coffer dam to be used, *Ridley* 5553–5555.

THAMES EMBANKMENT AND NORTHERN LOW LEVEL SEWER—continued.

1. *Details in connection with the Non-acceptance of the Tender, &c.*—continued.

Witness, who is a member of the Metropolitan Board of Works, was one of the Committee which dealt with the tenders for the first section of the embankment and northern low level sewer, *Roche* 5613. 5618——Witness hesitates about divulging the conversations which led to the rejection of Mr. Ridley's tender for the first portion of the low level sewer and embankment; is however prepared to do so, as urged by the Chairman of the Committee, *ib.* 5615–5619.

The tender of Mr. Ridley was in fact eventually rejected because of a report by Mr. Bazalgette that he was not competent to carry out the contract, *Roche* 5619–5721. 5639–5641. 5655–5660. 5668, 5669——Witness made careful inquiry as to the capabilities of Mr. Ridley, and felt satisfied that he was competent to carry out the contract, *ib.* 5622——Offer of Mr. Ridley to deposit the whole amount of the security required by the Board, whilst he was aided by the experience of Mr. McCormick as to the execution of the works, *ib.* 5623–5629.

Witness was guided by the engineer's report in regard to his vote upon Mr. Ridley's tender, *Roche* 5641. 5655——The tender of Mr. Ridley was in the first instance accepted, conditionally, by the Board, and the adverse report of the engineer was made to a committee of the whole Board, *ib.* 5657, 5658. 5668, 5669——Witness considers that the ultimate rejection of Mr. Ridley's tender has been detrimental to the interest of the ratepayers, and has always thought that he was very hardly treated by the Board, *ib.* 5727, 5728.

Opinion that the securities and capabilities of Mr. Ridley for the execution of the contract for the first section of the Thames embankment were perfectly ample; grounds for this conclusion, *Nicholay* 5731, 5732. 5756. 5761–5763——Injustice inflicted on Mr. Ridley, more especially as his tender was at first accepted very unanimously by the Board, subject to inquiry in regard to security, *ib.* 5731, 5732. 5809. 5812–5814——Great increase of expense to the ratepayers by the eventual rejection of Mr. Ridley's tender, *ib.* 5731. 5748.

Conclusion that the rejection of the tender was owing to the adverse report and influence of Mr. Bazalgette, *Nicholay* 5733–5739——Witness is decidedly of opinion that the first acceptance of Mr. Ridley's tender by the Board would not have been set aside but for the objections of Mr. Bazalgette, *ib.* 5821, 5822.

With regard to the ultimate rejection of Mr. Ridley's tender, witness explains that the Board were guided in the matter by confidential information received relative to Mr. Ridley, and submits that he should not be required to divulge such information to the Committee or the public, *Thwaites* 5928–5936——The information was of an influential character, as coming from Mr. Ridley's own employers, *ib.* 5932. 5936.

Communication from Bazalgette to the Metropolitan Board, in which further explanation is given of the part taken by him in connection with the non-acceptance of the tender of Mr. Ridley, *App.* 501.

2. *Cause of the Non-acceptance of the Tender of Messrs. Baker and Son:*

Statement as to the tender of Messrs. Baker and Son not having been accepted because it involved an arbitration clause, *Roche* 5672. 5674——Witness explains that the absence of an arbitration clause was not the only cause of the tender of Messrs. Baker and Son for the first section of the low level sewer and embankment not having been adopted, *Thwaites* 5831–5835——Statement by Mr. Bazalgette as to his having strongly recommended the tender by Messrs. Baker and Son, *App.* 501.

3. *Considerations as to the acceptance of the Tender of Mr. Furness, though higher than the two preceding Tenders:*

Mr. Furness is the contractor for the first portion of the low level sewer, though his tender was not the lowest by some two or three, *Bazalgette* 5243–5247——Witness cannot name any works as having been performed by Mr. Furness, similar in character to the embankment, *ib.* 5369–5374.

The tender of Mr. Furness, though 25,000*l.* in advance of witness's contract, was ultimately accepted, *Ridley* 5405, 5406. 5567.

Testimony borne by Mr. Bazalgette to the past experience of Mr. Furness as a contractor, although he reported very positively against Mr. Ridley; opinion as to the inaccuracy of each of these views, *Roche* 5647–5656——Explanation as to the Board having decided not to re-advertise for fresh tenders after the rejection of the tenders of Mr. Ridley and Messrs. Baker and Son; dissent from this determination, *ib.* 5675–5677. 5699–5701. 5706. 5721–5724.

Decided objection made by witness to the report of the committee of the Board granting the contract to Mr. Furness, *Nicholay* 5749–5757——Satisfactory manner in which Mr. Furness had previously executed some works for the Board, *ib.* 5750–5754. 5758–5760——Concurrence of witness in the reasons of the Board for not advertising for tenders in lieu of accepting the tender of Mr. Furness, *ib.* 5764–5766. 5815, 5816.

Information

THAMES EMBANKMENT AND NORTHERN LOW LEVEL SEWER—continued.

3. *Considerations as to the acceptance of the Tender, &c.*—continued.

Information supplied by Mr. Bazalgette in communication to the Metropolitan Board relative to the course pursued by him with reference to the tender of Mr. Furness, *App.* 501, 502.

4. *Particulars relative to the Material being used by Mr. Furness in the Construction of the Work; large Profit of the Contractor on this Score:*

Examination as to the contractor for the first portion of the Thames embankment using a large quantity of clay and brick rubbish in its formation, instead of material dredged from the Thames, as contemplated under the specification, *Bazalgette* 5352–5368——The conservators do not supply material fast enough for the work, *ib.* 5361. 5366——Probable large reduction in the amount of the contract if it had been known that material could be obtained from the land, at 8*d.* or 1*s.* a load for taking it; doubt as to so large a saving as 20,000*l.* on this score, *ib.* 5363. 5365–5368. 5375–5378——Opinion that the Thames gravel and mud would not have made so good an embankment as the material from the land, *ib.* 5364.

Clear understanding given to intending contractors that the materials for the embankment were to be obtained from the Thames conservators at the expense of the former, *Ridley* 5444–5449.

Calculation that each tender would have been 69,000*l.* less, but for the understood necessity of taking the Thames mud and gravel, and that this saving, together with the receipt for allowing rubbish to be shot amounts to 80,000*l.* on the part of the contractor, *Cleaver* 5451–5473. 5527–5534——Inferior character of this rubbish for the purpose of the embankment as compared with Thames gravel, *ib.* 5461. 5466–5468. 5535–5542——Statement as to the rubbish having been shot before the completion of the cofferdam, so that much is washed away to the injury of the river, *ib.* 5475–5485.

Great crowding of Fleet-street and other thoroughfares by the carts bringing rubbish for the embankment, *Cleaver* 5486–5488. 5543–5547——As many as 740 loads have been shot in one day, *Ridley* 5489–5491——The price for the liberty of shooting is 6*d.* or 9*d.* a load, *Cleaver* 5493, 5494.

Witness is not aware whether the Board of Works have applied to the Conservancy Board for supplies of Thames gravel, but rubbish has been used for a considerable time, *Ridley* 5594–5599——The contractor for the second section of the embankment is also using rubbish in lieu of Thames gravel, *ib.* 5600–5602.

Reference to the use, by Mr. Furness, of rubbish from the land instead of Thames dredgings in the formation of the embankment works; doubt as to any report by the engineer on this point, *Roche* 5662, 5663. 5670, 5671. 5682–5692——Impression as to the Thames Conservancy having complained of the material being used in filling up the embankment, *ib.* 5687–5691.

Expediency of some official inquiry in regard to the rubbish material being used for filling up the Thames embankment; benefit to the contractor thereby, whilst the streets are much obstructed by the carts, *Nicholay* 5778–5781. 5792–5794. 5800–5803——Statement as to there not being any close inspection of the embankment works by a committee of the Board, *ib.* 5790–5793——Twofold object of the intended use of Thames gravel for the embankment works, *ib.* 5794. 5804–5807.

Letter from Mr. Bazalgette to the Committee, dated 4 July 1864, in further explanation of the course pursued under the contract in regard to the material used, *App.* 498, 499——Statement by Mr. Bazalgette showing that a large portion of the material has been supplied by the Thames conservators, *ib.* 498.

Letter from Mr. Burstal to the Chairman of the Committee, dated 14 July 1864, stating that since 7th June Mr. Furness has not taken any material from the Thames Conservancy, and that all supplies since that date have been used under Mr. Ritson's contract, for the second section of the embankment, *App.* 502——Memorandum as to the quantity of material supplied for each contract, *ib.*

5. *Payment to the Contractor on account of Work done:*

Opinion as to the small quantity of the embankment work done by Mr. Furness at the end of May, when he was paid 33,000*l.* on account, *Ridley* 5520——Estimate that when the 33,000*l.* was paid, the work done did not represent 10,000*l.*, *Cleaver* 5521–5526.

Return showing the time when the contract was entered into, the time for completion, the amount paid on the contract, &c., *App.* 489, 490.

6. *Conditions in regard to extra Works and Provisional Quantities:*

Particulars as to the provisions made for extra works, in addition to materials on "provisional quantities," *App.* 494–496.

THAMES EMBANKMENT AND NORTHERN LOW LEVEL SEWER—continued.

7. *Estimate of the Cost of the Embankment on the North Side:*

Total of 1,400,000*l.* as the estimate of the amount required for carrying out the Thames embankment on the north side, including the cost of compensation, *App.* 492.

See also *Bazalgette, Mr.*

Thudichum, Dr. Reference to the plan of Dr. Thudichum for dealing separately with the urine, by means of some mechanical arrangement applied to each house; witness is not prepared to offer any opinion upon this scheme, *Thwaites* 176–178. 181——System of separate house drains and closet pans proposed for each house by Dr. Thudichum, with a view to carrying separately the urine to Barking, and there manipulating it, *Bazalgette* 179——Opinion as to the impracticable character of this scheme, *ib.* 179, 180.

Communication from Dr. Thudichum to the Metropolitan Board of Works, submitting a plan for dealing with the sewage by producing from the urine a portable manure, *App.* 298–303——Way in which it is proposed to convey the urine from the houses to the outfall at Barking Creek, *ib.* 298.

Grounds for estimating a gross return of about 1,365,000*l.* from the urine manure, or a net surplus of 1,100,000*l.*, after paying a dividend of seven per cent. on the proposed capital of 1,500,000*l.*, *App.* 298——Calculation that the metropolis would yield upwards of 1,000,000 tons of urine per annum, *ib.*——Estimate of 33*l.* per ton as the value of the manure to be produced from the urine, *ib.*——Calculation that 30,000 tons of portable manure would be produced annually from the urine, at a cost of 5*l.* per ton, *ib.*

Details explanatory of the proposed plan for collecting the urine of each house, *App.* 301–303——Tables containing detailed data as the foundation of the scheme, showing the statistics of urine and fæces produced in the metropolis, and the manurial properties contained therein, *ib.* 303–314.

Thwaites, John, and Joseph William Bazalgette.—(Analysis of their Evidence). (*Mr. Thwaites.*) Has been chairman of the Metropolitan Board of Works since 1855; is also chairman of the Main Drainage Committee, 1–3——The tenders for the utilisation of the sewage of the metropolis have been considered by witness and Mr. Bazalgette, 4, 5——The Board first advertised for tenders in January 1860, and again advertised in March and May 1863, 7–9——With regard to certain conditions required on the part of those tendering, witness explains the object of these conditions, and does not consider that they are too costly or too stringent, or that they would act as any undue hindrance to tenders being submitted, 10–28.

Several persons or companies from whom tenders were received up to 1 January 1862; outline of the proposals involved in each tender, 29–36. 47 *et seq.*——Proposal by the London Sewage Utilisation Company to utilise the sewage in a liquid state, 32——(*Mr. Bazalgette.*) Belief that the area proposed to be dealt with by this company was about 20,000 acres, 37. 44——Witness reported only upon one of the tenders under consideration, 38–41——Terms or rent offered by the company before named, 45.

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1. *Papers explanatory of the Scheme submitted by Lord Torrington, Sir Charles Fox, and Mr. Thornton Hunt.*
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7. *Works.*
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1. *Papers explanatory of the Scheme submitted by Lord Torrington, Sir Charles Fox, and Mr. Thornton Hunt:*

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Walker, George Henry. (Analysis of his Evidence.)—Took a lease of the sewage of Rugby in 1853, with a view to preserve the river from pollution and to fertilise his own land, 3603–3606——Erection of a tank and steam engine, with pipes and open gutters, for purposes of distribution, 3607–3610. 3694–3696——Witness first used a gutta percha hose, but has found open gutters more satisfactory, 3610–3612. 3697–3701——Successful results from the application of the sewage, especially in the case of green crops and grass land, 3613–3616. 3640–3643. 3654–3670——Doubt as to sewage being of much benefit to wheat crops, 3616. 3640–3643.

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Water Companies. Intention, under witness's scheme, to follow the practice of the water companies, and to distribute by meter, at the option of the farmers, *Ellis* 1913-1917. 2013. 2019.

Water Irrigation. Excellent effect upon the land by the natural filtration of the water through it, *Mechi* 3429-3431.——*See* also *Valentia.*

Water Supply. Conclusion as to the health of persons being greatly injured who use the waters of rivers into which town sewage flows, even though the water has been filtered, *Whitehead* 2756-2762. 2771-2773. 2811-2817——The rivers of the country are generally in a most lamentable condition with reference to the purposes of water supply, *Rawlinson* 3993——Consideration of the effect upon health by the use of water from rivers into which sewage is discharged, *ib.* 4016-4020. 4026——Impracticability of entirely purifying by any chemical means river water which has been polluted by sewage, *Way* 4702-4708. 4741-4753.

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WATERSHED BOARDS (CATCHMENT BASINS OF RIVERS):

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Way, Professor John Thomas. (Analysis of his Evidence.)—Analytical chemist; is a member of the Sewage Commission, 4698–4701——Impracticability of entirely purifying by any chemical means river water which has been polluted by sewage, 4702–4708. 4741–4753——Effect of precipitation, if applied at Oxford, &c., in greatly improving the London water supply, 4705. 4742–4748——Necessity of using the sewage of towns in a liquid form upon land, as the only alternative if it be excluded from the rivers, 4709–4712. 4754——Inaccuracy of the assumption that the sewage is, on the whole, richer during storm overflows than at other times, 4713–4720——Very valuable effect of weak sewage as applied to land near Milan, 4721, 4722.

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Statement to the effect that the London sewage may be best applied to a sandy soil like that at Bagshot Heath, inasmuch as it would greatly improve the soil, and would partly find its back way back into the Thames, in a comparatively pure state, 4914–4936——Important benefit of sewage to farmers if they might take it when they pleased, and if the Company supplying it could themselves utilise all that was not required by the farmers, 4938–4941. 4993–4995——Absence of any real nuisance if sewage be applied in small quantities by hose and jet, 4942–4944——Radical difference between the sewage used by Mr. Mechi and London sewage, 4944, 4945.

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Probable increase in the commercial value of sewage manure on account of the increasing demand for artificial manure, 4963–4965. 5002, 5003——Way in which the utilisation of sewage may act advantageously to the manufacturers of guano, &c. 4966–4968——Wasteful use of the sewage applied to the meadows at Edinburgh, 4971–4975——Immense area necessary if the London sewage is to be applied without waste, and only when convenient to the farmers and beneficial to the land, 4977——Witness repeats that small dressings of sewage are beneficial, and that corn may be benefited by a limited irrigation, 4978–4980——Beneficial results when sewage, although in a very diluted state, is applied largely to grass land, 4981, 4982.

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4996–5001——Doubt whether the ultimate passage of sewage through osier beds would act effectually as a deodoriser, 5004–5006.

Wells (Somerset). Greatly polluted state of the stream which takes the sewage of the city of Wells, *Whitehead* 2729–2738.

West, William. (Analysis of his Evidence).—Represents the firm of West & Sons, of the St. Blazey Foundry, at Par; has had great experience in the erection of pumping engines, 2138, 2139——Objection to water or sewage being pumped to a height of more than 200 feet at one lift, on account of the strain upon the pump, 2140–2144——Statement as to the horse power required in proportion to the height to be lifted, 2145–2147——Cost of about 35 *l.* per actual horse power for the erection of the Cornish engine, with boilers, exclusive of buildings; reduction to about 30 *l.* when erected in duplicate, 2148–2152.

Suggestions as to the kind of pumps and valves to be used in lifting the London sewage, 2151. 2153——The total cost of lifting 1,000 tons fifty feet high is 2 *s.* 4 *d.*, and an additional 2 *s.* 4 *d.* for every additional fifty feet, 2151. 2154–2158. 2175–2177——A very small decimal would represent the cost of lifting each ton of liquid, 2151. 2159, 2160——Recommended use of a brass wire sieve, in the form of a basket, for preventing any hard matter getting to the entrance of the suction pipe, 2151. 2161, 2162. 2165–2167——Statement as to the facility and great economy of conveying clay, through the medium of water, by gravitation; inference as to the facility of a similar conveyance of the London sewage, 2163–2174. 2178–2181.

Western Sewage (Main Drainage). Explanation that the sewage of the western division was not at first intended to be conveyed to the reservoir at Barking, or the latter would have been planned on a larger scale, *Bazalgette* 5165. 5168. 5183——The sewage of the western division will eventually come into the Victoria Sewer and go along the Thames Embankment, *ib.* 5277–5279.

List of the names of the contractors who tendered for the works, and of the amount of the several tenders, with the names of the sureties proposed, *App.* 483——Further statement showing the tender accepted, the amount thereof, and the names of the sureties accepted, *ib.* 488——Returns showing the time when the contract was entered into, the time for completion, the amount paid on the contract, &c., *ib.* 489, 490——Particulars as to the provision made for extra works, in addition to materials or provisional quantities, *ib.* 494–496.

Westminster Board of Works. Resolution of the Board with reference to the importance of a general application of the sewage for agricultural purposes, as compared with its application to a limited tract of barren coast land, *App.* 446.

Weston-super-Mare. Information relative to the pollution of the River Rhyne by the Weston-super-Mare sewage, so that the cattle using the water have been injured, and the fish destroyed, *Whitehead* 2711–2728——Failure of some works for applying the lime process at Weston, *ib.* 2718–2727.

Wheat. Instance of the beneficial effect of a small application of sewage to wheat land, *Ellis* 1823——Conclusions as to the value of sewage to wheat, &c., if properly applied, *Whitehead* 2909–2912; *Mechi* 3343. 3394–3396——Doubt as to sewage being of much benefit to wheat crops, *Walker* 3616. 3640–3643.

Information relative to a former application by witness of sewage to wheat land, and the very successful effect thereof over a course of years, *Dales* 3763–3791——There were ten acres, to which the sewage from thirteen cottages was applied, *ib.* 3773–3776——The sewage was greatly diluted before application, and was applied by means of a watering-cart, *ib.* 3776–3784——When witness bought the land it was almost exhausted, *ib.* 3786——He paid eighty guineas an acre for it, and now lets it for six or seven guineas an acre, *ib.*

Quotation of the views of Baron Liebig and the Earl of Essex as to the value of sewage applications to wheat, *App.* 346.

Whitehead, Arthur. (Analysis of his Evidence.)—Civil Engineer; is county engineer and surveyor of Somersetshire, and has carried out works for combined water supply and sewage in several towns in the counties of Devon and Somerset, 2692–2698——Prospect of the adoption of some plans made by witness several years ago for utilising the sewage of Exeter, 2699–2702——Plans made by witness in 1854 for utilising the sewage of Exmouth; cause of their not having been carried out, 2703, 2704——Very imperfect attempt made to intercept and utilise the sewage of Sherborne, 2705–2710.

Information relative to the pollution of the River Rhyne by the Weston-super-Mare sewage, so that the cattle using the water have been injured and the fish destroyed, 2711–2728——Failure of some works for applying the lime process to the sewage of Weston, 2718–2727——Greatly polluted state of the stream which takes the sewage of the City of Wells, 2729–2738——Very polluted condition of the River Exe on account of

Whitehead, Arthur. (Analysis of his Evidence)—*continued.*
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Particulars relative to the sewage works carried out by witness at Ottery St. Mary, and the very beneficial effect thereof upon the local health, and upon the water of the stream flowing by the town, 2749–2767——Baneful effect upon the health of persons using water from rivers into which sewage flows, 2756–2762. 2771–2773. 2811–2814——Pollution of this stream by the sewage from several villages situated on it, 2768–2771——Nuisance arising from the sewage of Exmouth; facility for utilising this sewage, 2774–2781.

Amount of the sewage of Taunton flowing into the River Tone; very polluted state of the river, no remedy having been attempted, 2782–2788——Very foul state of the River Froom, into which the Dorchester sewage flows, 2789–2797——Pollution also caused by the sewage of Sherborne, the river into which it flows being unfit for the use of cattle, and not containing any fish, 2798–2810——Conclusion as to the health of persons being greatly injured who use the water of rivers into which town sewage flows, even though the water has been filtered, 2811–2817.

Approval of a legislative provision that sewage should not, any more than gas refuse, be allowed to flow into rivers, 2818–2820——Necessity of dealing at the same time with the whole of each catchment basin under one uniform authority, 2821, 2822. 2896–2901——Increase of the evil through the increased use of water-closets and better drainage, 2823, 2824——The only effectual remedy is to utilise the sewage by applying it to land, 2825–2827——Conclusion as to the land acting as an excellent deodoriser upon sewage matter, 2830–2834.

Opinion that the best plan for making the most of town sewage is to separate the urine and manufacture it into a dry manure, utilising separately the other matter; way in which the urine might thus be dealt with, 2834–2842. 2884–2891. 2894–2898——Necessity of an Act of Parliament compelling local Boards to take action in the matter, 2843. 2896——Conclusion as to sewaged rivers being decidedly injurious to cattle, 2844–2848——Also to fish, 2849–2854——Want of more stringent regulations for preventing foul or polluting substances being thrown into rivers, and for excluding the refuse from mills, 2855–2873.

Greatly increased crops obtained from fifteen acres of land near Ottery St. Mary, over which the sewage of about 500 persons was carried; very diluted state of this sewage, 2874–2879. 2914–2917——Opinion that the sewage from seven to ten persons would be quite sufficient for each acre, 2880–2883——Expediency of bringing clearly before the public the value of sewage as a manure, 2892–2895——Belief as to the value of sewage in the case of arable land, if properly applied, 2909–2913.

Wicksteed, Thomas, C.E. Report by Mr. Wicksteed upon the most advantageous mode of dealing with the sewage matter of the metropolis, with a view to the preparation of sewage manure, *App.* 407–414.

Winchester Hospital. Diminished disease in Winchester Hospital since the uncovering of the hospital cesspool upon a plan suggested by witness, *Rawlinson* 4221, 4222.

Winter Months. Value of sewage in winter, or in wet weather, as well as in summer, for agricultural purposes, *Mechi* 3392, 3393——Statements in illustration of the manurial value of sewage for grass land in cold seasons, *App.* 346.——*See* also *Frost.*

Works (Utilisation of Sewage). Opinion as to the practicability of the several schemes submitted to the Metropolitan Board, including the Maplin Sands Reclamation Scheme, if money enough be spent upon them, *Hopkins* 1072–1075.

See also *Croydon,* 3. *Liquid Sewage Manure Company. London and Provincial Sewage Company. London and Provincial Towns Sewage Irrigation Company,* 5. *London Sewage Utilisation Company. M'Clean, John R. Metropolis Sewage and Essex Reclamation Company,* 2–7. *Pipes and Mains. Pumping or Lifting the Sewage. Torrington, Lord, and others.*

Worthing. Information relative to the steps being taken by witness and others for utilising the sewage of Worthing, *Rawlinson* 4105, 4106. 4149. 4162——It is intended to apply the sewage to forty-two acres of land, the population being 7,000, *ib.* 4106. 4149. 4162.

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